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A

Treatise on Surgery

BY

AMERICAN AUTHORS.

### FOR STUDENTS AND PRACTITIONERS OF SURGERY AND MEDICINE.

EDITED BY

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VOLUME II.

SPECIAL OR REGIONAL SURGERY.

WITH 451 ENGRAVINGS AND 17 FULL-PAGE PLATES
IN COLORS AND MONOCHROME.
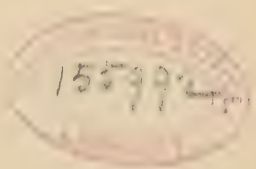
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PREFACE TO VOLUME II.

On behalf of his fellow-collaborators the Editor takes this occasion to thank the surgeons and surgical teachers of America for the cordial reception so quickly extended to the first volume of the work, and to express the hope that the second and concluding volume may be similarly approved, both from the didactic and practical standpoints.

If it be possible to judge from the written expressions already received from the most prominent teachers of Surgery, the work seems likely to fulfil one of its chief purposes—namely, the presentation of a thoroughly modern text-book reflecting the methods of teaching developed by large experience.

Practitioners of surgery, it is hoped, will find it equally suited to their needs, as every effort has been made to afford all necessary guidance in the principles as well as in every practical detail of surgical science and art.

The illustrations, which are largely original, have been chosen with critical care, and each of the profuse series will be found to elucidate important matters and to supplement the text most valuably.

It is no small task to gather a comprehensive and authoritative expression of modern surgical knowledge. How far this effort has succeeded it remains for the surgical public to determine, but the Editor can at least say that he submits with confidence these volumes, embodying as they do the most earnest work of the eminent gentlemen whose information is a credit and honor to the position of America in the surgical world. The Editor also wishes to renew here his expressions of obligation to the gentlemen who have so kindly assisted him, as mentioned in the Preface to the First Volume.

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BUFFALO, October, 1896.

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CHAPTER I.

INJURIES AND SURGICAL DISEASES OF THE HEAD.

BY ROSWELL PARK, M. D.

THE SCALP.

Erysipelas and cellulitis of the scalp are the result of the same infections and conditions as when met with in other regions, but are peculiarly prone to occur here because of the liability to infection from the hair with the material concealed in and upon the surface. They lead frequently to suppuration, in which case abscesses form that may extend inside the cranium, as into the frontal or other sinuses. These are common about the orbit and in the upper eyelid, and unless speedily incised may lead to gangrene. Multiple abscesses are also common. Disturbances of sight and hearing as sequels of these infections are occasionally met with. The principal danger from these purulent collections pertains to intracranial infection or general sepsis, usually of pyæmic type.

Carbuncles are frequent upon the back of the neck, though they seldom occur upon the scalp proper. Even small ones are rarely met here. Nevertheless, carbuncles have been known to extend from one ear around to the other. Occurring in this region, the infection is serious and prognosis is unfavorable. Met with here, they should be treated, as elsewhere, by free incision, with extirpation of all infected tissues. Their presence should always excite the suspicion of diabetes, alcoholism, or pronounced uric-acid diathesis ; for each of which, when recognized, appropriate medication should be adopted.

Gangrene of the scalp may result either from infection or injury. In badly-nourished children it may follow various skin eruptions. That type known as gangrenous emphysema may also be met with here. All forms of gangrene may be followed by necrosis of the underlying skull, especially when the periosteum is involved. Threatening gangrene should be treated by early excision of the suspicious area, or at least by incision to relieve tension. Actual gangrene should lead to prompt extirpation of all infected tissues.

The various ulcerations of the scalp which may result from wounds, phlegmons, carbuncles, etc., as well as from the infectious granulomata—*i. e.* syphilitic and tubercular—or those of cancerous nature, differ only from other ulcerations elsewhere by the accident or limitation of their location. The most common ulcerations of non-traumatic origin are due to breaking down of neoplasms. The treatment for each of these does not require special mention here, having been already described in the other parts of this work.

Gaseous Tumors of the Scalp.—The most common of these is ordinary emphysema, which may result from injury to the upper air-passages

or even involving the lower. Thus, fractures of the nasal bones or of the base of the skull may permit the distention of the subcutaneous cellular tissue by forcible inspiration of air. Emphysema of the scalp may be a valuable diagnostic feature in certain instances. When connected with a wound it would best be enlarged in order to permit the escape of contained air. Otherwise, these puffy swellings usually disappear spontaneously by absorption of air into the veins. In cases of malignant or gangrenous emphysema, early and numerous incisions should be made, after which antiseptic solutions, etc. should be generously resorted to.

Pneumatocele.—A pneumatocele is a chronic gaseous tumor, being a cavity distended with air which has escaped from the cells of the underlying bone, bounded on the outside by the scalp, beneath by the cranium. They are met with about the mastoid or the frontal region. Not more than two dozen cases in all are on record. In consistency these tumors are elastic, while the escape of air upon pressure is sometimes to be heard upon auscultation. Their explanation is almost always a defect of the inner wall of the mastoid cells, through which air may be forced from the pharynx through the middle ear by violent effort. Bony defects which might permit this condition are met with in a small percentage of craniums.

The best results in the way of TREATMENT have been achieved by puncture, with the injection of weak iodine solution.

Syphilis of the Scalp.—The scalp may be the site of syphilitic eruptions, ulcerations, or necroses. These differ in no respect from similar lesions elsewhere. In syphilitic disease of the bones there is greater ease of infection and breaking-down of the overlying skin because of their proximity. Gumma of the soft parts or of bone, and caries of the latter, will nearly always lead to superficial ulceration, which shall call for a combination of local surgical and general medical treatment.

Tuberculosis of the Scalp.—This same may be said of tubercular lesions, which when superficial will, for the most part, assume the lupoid type, or when deep will be inseparable from other manifestations of tuberculosis of the flat bones.

Tumors of the Scalp.—These may be divided into the *congenital* and the *acquired*, as well as into the benign and malignant.

Of the congenital tumors, the dermoids are of most interest. In order to fully understand dermoids of the cranium we must remember that originally the dura and the skin were in contact, and that the cranial bones develop as an after-thought. This will explain the occurrence of dermoids either beneath or outside of the bone or their simultaneous appearance and possible connection. Many of the so-called atheromatous cysts or wens are really of dermoid origin. Those which are extracranial need only antiseptic incision or excision. It will often be enough to split such a cyst with a bistoury, after which each half of the sac can probably be easily detached from the bed in which it has lain. Should intracranial connection be discovered, the bone-chisel and sharp spoon will be necessarily called into employment. Some of these dermoids perforate into the orbit, and may have to be followed into that location.

All of the *dermoids* and *cysts* of the skull may require to be differentiated from meningoceles and prolapsus cerebri : in fact, one should always distrust a congenital tumor about these regions, but particularly those near the middle line. The external tumors never alter in size during sleep, and can rarely, if ever, be pressed back within the cavity of the skull ; which cannot be said of either of the

other conditions just mentioned. In case of doubt the exploring needle may be used.

Cornu cutaneum is seen more often upon the scalp than elsewhere, its explanation being afforded in the chapter on Tumors in Volume I. It calls for complete excision, which, if thorough, will be sufficient.

Of the other tumors, benign or malignant, most varieties may be met with in this region. Subcutaneous collections of *fat* are not so common, nor are *fibromata*. Various *bony* growths may be met with, while in certain cases the signs of brain-pressure are to be explained only by their extension within the cranium.

Malignant tumors are common about the scalp and the cranium; they assume, however, no conventional appearance, and may be met with in any shape or form, those of the scalp alone occurring either as carcinoma or epithelioma from its epithelial elements, or as sarcoma from its mesoblastic elements. Tumors primary in the periosteum or bone must necessarily be of sarcomatous nature, while those of the type which perforate to the surface may be either sarcoma or possibly endothelioma. With regard to the general character of these growths enough has been already said in Volume I. Concerning their extirpation (for there is no other treatment than this), operations of varying degrees of severity may be called for.

The superficial epithelioma should be, if possible, attacked before it has become adherent, in which case everything should be removed down to the underlying periosteum, after which a plastic operation will permit the repair of the defect, so that primary union of the whole surface may be secured. Any malignant growth which is adherent to the underlying cranial bone calls not only for removal of its own substance, but for that of the bone to which it is attached. To fail in this is to invite recurrence. This may necessitate more or less extensive osteoplastic resections of the bone, but the condition permits of no middle course. Very extensive resections of bone have been made with success, and need not be abstained from unless there be good reason to fear involvement of the dura or cortex. In this case the advantages and dangers must be carefully weighed before proceeding to operation. During operations on the bone great care should be taken, especially in certain regions, to avoid injury to the intracranial sinuses, although we have learned that these may be ligated and intervening portions removed—almost with impunity when necessary. But the wounding of the sinus by the point of an instrument or spicule of bone may lead to a most hazardous and annoying complication, and is to be prevented when possible. A small wound in a sinus may be plugged with gauze, which may remain for two or three days. There is always a possibility of air-embolism (see Chapter II. Vol. I.) when the sinuses are opened, since their walls do not easily collapse. Hemorrhage from the soft parts may be almost entirely controlled by the use of an elastic tourniquet stretched around the skull. Oozing veins in the diploë or in the bone may often be secured by pressing the tables of the skull together with bone-forceps, while at other times an antiseptic wax can be forced into the interstices of the bone and hemorrhage thus be checked. In certain cases where it seems impracticable to slide flaps and cover defects, the desired end may be obtained by skin-grafts after Thiersch's method.

DISEASES OF THE BLOOD-VESSELS.

Aneurisms and vascular tumors, especially the latter, are met with about the scalp. The form of aneurism most common is the so-called cirsoid, already described in Chapter XXXII. Vol. I. Single aneurisms are, however, occasionally seen. These are, when upon the surface, always accessible, and are best completely extirpated. Cirsoid aneurisms, when not too large, may be radically attacked, or, if excessive in

size, may justify ligation of both external (or even both common) caro-
tids. The ordinary venous tumors, so-called nævi, etc., may either be
excised or treated by electrolysis. Arterio-venous aneurisms, either
external or connecting with the orbit or with an internal sinus, have
been seen and described, but are so rare as not to warrant further men-
tion here. Varicose conditions of the external veins are also occasion-
ally seen. These may be due to mere weakness of venous walls, or may
be the result of disease of the same or of obstruction to return circu-
lation.

A rare and specialized form of blood-tumor, met with only on or within the
cranium, is the so-called hernial dilatation of the superior longitudinal sinus. It
may present through openings in the bone; sometimes pressure upon it will cause
vertigo and perhaps greater prominence of adjoining veins, even of the jugulars.

Non-inflammatory Diseases and Congenital Conditions of the Skull.

Incomplete formation of bone (*aplasia cranii*) is occasionally met
with. The bone is a secondary formation in the skull, the dura and skin
being originally in contact; consequently, this condition can be easily
explained as a failure to develop bone where it is normally met with.
These defects are most common in the frontal and temporal regions.
The bone may fail also to develop to ordinary thickness, and may be

Fig. 1.
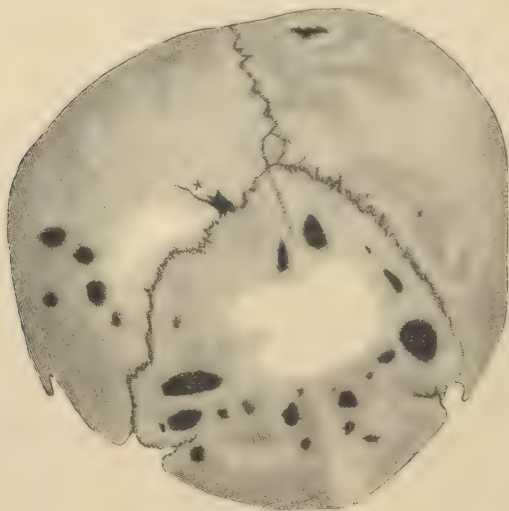
Craniotabes (rhachitis) (Bruns).

found as thin as paper or ossifying only in certain directions. Super-
numerary bones may also develop, apparently to take the place of those
previously lacking. *Aplasia* may also be a *unilateral* defect and con-
tribute toward the formation of meningocele. *Atrophy* or *anostosis*—
i. e. complete disappearance of cranial bones—is occasionally observed.
It may be an interstitial or an eccentric process, and may happen at any

point or at several spots. Up to a certain extent it is the rule in the skulls of the aged, where the bones become reduced to the thinness of paper or may in certain places completely disappear. *Senile atrophy*, in

FIG. 2.
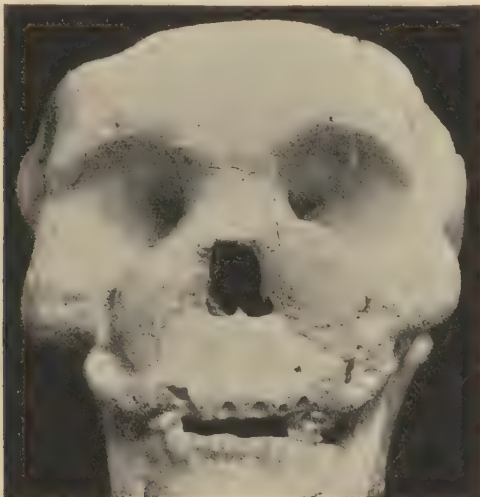
Leontiasis: skull of a Chinese woman (U. S. A. Museum, No. 10,620).

other words, is a normal process, and is to be expected after the sixtieth year of life, its possibility being not forgotten when operations are undertaken upon the skulls of those advanced in years. Eccentric atrophy

FIG. 3.

Osteoma of skull (Mudd).

may also occur from pressure of soft or hard tumors, among them the so-called Pacchionian bodies. It is stated also that increasing hydrocephalus may produce an internal and eccentric anostosis.

Craniotabes or Cranial Rickets.—It is particularly in the skull

Fig. 4.
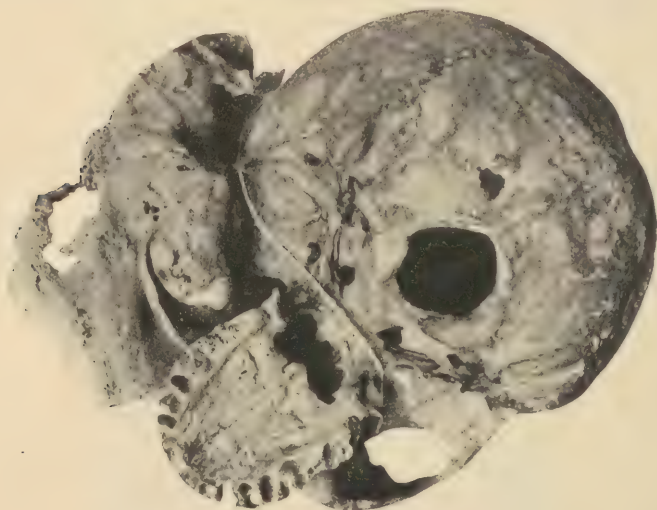
Same, seen from below.

that the manifestations of rickets are most common, the bone becoming unduly thick and the general shape being changed.   Usually there is

Fig. 5.
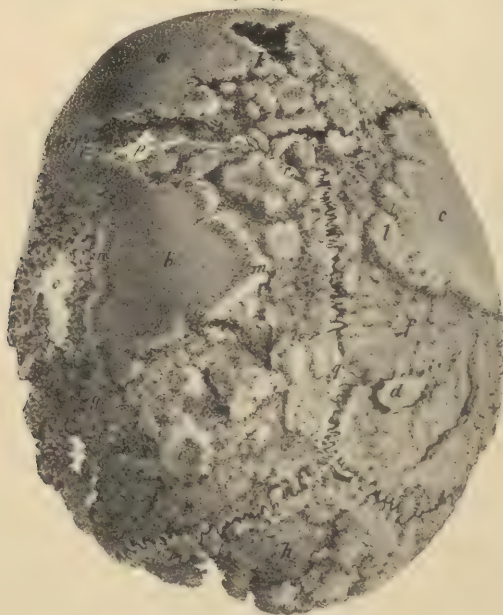
Syphilitic caries of cranium (Bruns).

flattened vertex with delayed ossification, with an abnormally firm union

along the suture lines. In spite of these changes, the bone often becomes affected by pressure to such an extent that a rachitic or hydrocephalic child, confined in bed and moving little or not at all, will develop a skull showing the effect of such pressure. Many rachitic skulls show areas of atrophic thinning, dispersed irregularly, while the inner surface may show the markings of the convolutions impressed upon it by the softness of the bone.

Leontiasis.—This has been already alluded to in Chapter XXXV. Vol. I. It refers to an abnormal thickening confined entirely to the skull and the facial bones. The trouble begins usually in the latter, but later involves the former. By the distortion of nature's purpose a most peculiar appearance is given to the face and head.

The PATHOLOGY of the disease is absolutely unknown : the influence, once operative, continues to act until the bone becomes enormously thickened, and patients die either of brain-pressure or of inanition, the latter caused by encroachment upon the natural cavities of the face and cranium to such an extent that swallowing becomes impossible. The condition is absolutely hopeless.

SURGICAL AFFECTIONS OF THE CRANIAL BONES.

The acute affections of bones have been already dealt with at considerable length in Chapter XXXV. Vol. I., and but little needs to be said here in addition to statements therein contained. *Acute periostitis* is, for the most part, due either to syphilis or to an infection following injury. In the latter case it proceeds from the margin of the wound, and may spread to a considerable distance. It is in some instances secondary to deeper infection extending from the middle ear, and then is found posteriorly to the ear and externally to the mastoid cells. Congenital openings or defects of the sutures about the mastoid seem to have much to do with the travelling of infectious lesions in these localities.

Acute osteomyelitis is due to essentially the same causes as those just discussed. In this case it is especially in the diploë that the principal ravages are met with. Unless very promptly recognized and relieved by surgical measures, this is exceedingly likely to lead to sepsis of the pyæmic type and at a relatively early period, the venous arrangement of the diploë favoring such type of disease.

Chronic periostitis, or *pericranitis,* assumes rather the ossifying type, and leads to a formation of new bone—at least when not of tubercular character. The chronic tubercular lesions, however, are practically all connected with the ravages of the granulation-tissue which always marks the presence of tubercular disease in bone, so that these affections assume the clinical form of caries of the skull. Cold abscesses are frequent in connection therewith. The tendency of the disease is nearly always to spread, and it should be checked as early as recognized. In other words, the bone-chisel and the sharp spoon are in these cases nearly always called into play, the consequence being that the dura is often exposed before the lesion is eradicated. This need occasion no alarm, but should give rise rather to a feeling of satisfaction at the thoroughness with which the surgical attack has been carried out.

Necrosis of the skull is ordinarily the result, directly or indirectly, of injury, in which cases it is usually of the acute form, a fragment which has been too much separated from its surroundings to live, giving evi-

dence of early and easily recognizable death. This necrosis is, for the most part, confined to the external table. Necrosis of slow origin is due either to tuberculosis or syphilis, perhaps more often to the latter. Under a cold abscess of the scalp or subperiosteal abscess will often be found at least a small area of dead external table which needs complete removal. Necrosis has also been observed to follow severe burns of the scalp.

Injuries to the Head Previous to and During Birth.

In utero the head is surrounded by amniotic fluid and is well guarded against injury. Nevertheless, as the result of penetrating wounds or of falls on the part of the mother such injuries do occasionally occur. Most of the cases of skull fracture reported as occurring before birth have really occurred during delivery. *Multiple fractures* of the skull of either character have been observed.

During the process of parturition there nearly always appears a tumor of the scalp in the new-born, commonly spoken of as the *caput succedaneum*, at the point where pressure upon the head has been least. It usually disappears quickly after birth. It is due to a collection of

Fig. 6.
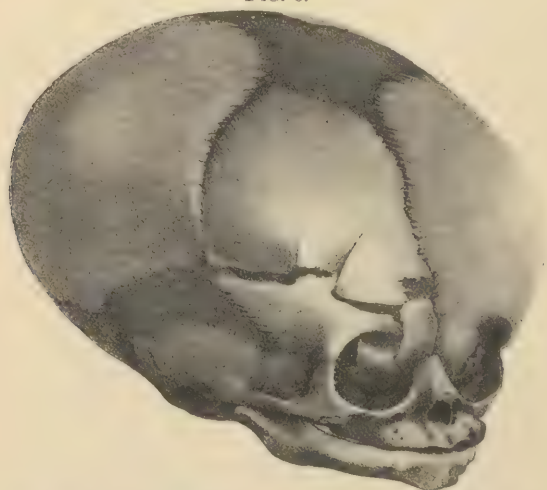
Fracture of right frontal bone in a new-born infant; fracture extending into orbit (Bruns).

blood, partly an extravasation, as the result of compression or injury. It is composed also of œdematous soft tissues of the surface. If incised, blood-stained serum is poured out. When this fails to rapidly resorb during the first days of the infant's existence, and especially if it fluctuate, it may be incised under antiseptic precautions and blood-clot be turned out or the necessary indication met in a judicious way. In rare cases it suppurates, by which is produced an acute abscess which naturally calls for prompt evacuation.

A collection of fluid blood between the periosteum and the bone is known as the **cephalhæmatoma neonatorum**, such a lesion occurring

on an average once in two hundred cases. It is met with most often over the fissures, and appears, at least in some cases, to be produced by the sliding of the bones. This collection also usually promptly disappears. In case of failure it may be aspirated or, if necessary, incised. Before resorting to any operative procedure it would be well to make a careful distinction between a possible meningocele or encephalocele as a congenital defect and cephalhæmatoma as an accident of delivery.

In the fœtal head the cranial bones are easily displaced, and during delivery the size and shape of the head are materially altered, as must necessarily be the case in view of the tremendous pressure to which it is subjected in passing through the pelvis. It has been claimed that the dolichocephalic form of certain skulls is due to pressure exerted in the necessary direction during face presentation. Premature alterations due to pressure may occasionally be met with, and may possibly give rise later to evidence of brain-pressure in the shape of epileptiform convulsions, etc.

A depression in the skull of a new-born child which does not quickly right itself or yield to expanding influences from within should not be long allowed to go uncorrected, since disastrous lesions, for the most part of paralytic type, may result therefrom. In these days of aseptic surgery there is no reason why such operation as may be necessary to elevate a fragment or an entire bone should not be performed with full precaution.

IMPORTANT POINTS IN THE SURGICAL ANATOMY OF THE SKULL.

It must be remembered, first of all, that the young and the aged have no distinction of tables of the skull, but that the diploë which separates the two tables is an affair of middle age, develops slowly, and disappears after the same fashion— sometimes to such an extent as to leave the skull of almost paper-like thinness. In all operations, then, upon the young and the old, one must proceed with extreme caution, as expecting to find the skull quite thin. The lower limit of the squamous bone proper is the so-called masto-squamosal suture, and operations confined to the squamous plate alone are safe from injuring the sigmoid sinus on its inner side. The ridge at the posterior root of the zygoma indicates by its lower border the level of the mastoid antrum. A few lines above this, is the level of the base of the brain. The *mastoid* is present at birth and appears externally by the second year. Its *antrum* is present also at birth, though its air-cells do not develop until after puberty, their location being previously occupied by cancellous tissue. Most of these cells open into the antrum, a few directly into the tympanum. They are not always separated from the sigmoid sinus by bone. The partition between them is perforated by minute veins, forming an easy communication between the sinus and the antrum. Air escaping from the mastoid cells into the overlying tissue may cause emphysema from a basal fracture. In all operations upon the mastoid antrum one should keep to its outer side, and the higher and the more closely to the posterior zygomatic ridge he makes the first opening, the more sure is he to escape injuring the facial nerve. The *groove for the sigmoid sinus* extends to the jugular foramen from a point on the outside corresponding to the asterion. The *lateral sinus* may be indicated externally by a line from the superior border of the mastoid to the inion—*i. e.* from the asterion to the inion.

The *frontal sinuses* are usually separated by a septum, which is often incomplete or wanting. They are variable in size and outline, and do not develop until after the seventh year—in some cases to a relatively very large extent. The *infundibulum,* by which they empty into the nasal cavity, is often so small that when the lining membrane is involved it becomes closed, and retention with its accompanying symptoms—pain, tenderness, swelling, etc.—may ensue. Ulceration and erosion, however, may cause perforation internally to the supraorbital plates, so that pus may penetrate through the inner half of the orbit.

Aside from its direct communication, the superior longitudinal sinus connects with the basal sinuses through the middle cerebral and the Sylvian veins, while

communications with the middle meningeal veins are quite free. Where the frontal and diploëtic veins enter the longitudinal sinus there are frequently dilatations in which marasmic thrombosis often originates. This sinus is also connected with the veins of the nasal septum, so that a septic phlebitis may be directly propagated from the nose. So much of the lateral sinus as is contained in the sigmoid groove is known as the *sigmoid sinus*, which connects directly with the exterior through the mastoid and the posterior condyloid veins. In sinus thrombosis this mastoid vein is usually likewise affected. One or more condyloid veins accompany the hypoglossal nerve through the anterior condyloid foramen, and may also serve for the propagation of infection or exit of pus.

While septic particles may be carried—usually through the internal jugular—from any part of the lateral or sigmoid sinuses, they may also be carried by way of the other veins above mentioned or the occipital sinus; all of which empty directly into the subclavian without passing through the internal jugular. These sinuses are all rigid tubes, always open, while the veins are thin and flexible, their calibre constantly varying with inspiration and expiration. The sinuses contain no valves, and these are very rare in the cerebral veins.

So far as the *lymphatics* are concerned, there is free and easy communication between the internal and external plexuses and nodes. Into the superficial nodes, along the external jugular, outside of the deep fascia, empty all the external lymphatics of the head. Intracranial infection shows itself in swelling of the deep cervicals beneath the deep fascia. Lymphatics are abundant in the dura, and pathogenic organisms, once housed within the dura, find it easily open to invasion.

The potential interval between the dura and the arachnoid is termed the *subdural space*, where considerable effusion may occur without marked symptoms, owing to its easy diffusion, while blood poured out here may travel even to the lowest parts of the spine and cause death by pressure upon remote points.

The *arachnoid* bridges over the convolutions and does not extend into the sulci. It is not vascular; at certain points it is adherent to the pia, at others does not touch it. The *subarachnoid space* is formed in the latter way, and within it most of the cerebro-spinal fluid is contained. This space is unevenly distributed over the brain surface, most prominent beneath the posterior two-thirds of the brain, where there is a wide interval between the arachnoid and the pia, extending forward over the medulla and pons and as far forward as the optic nerves. This space connects with the ventricles by the foramen of Magendie, as well as with the sheaths of the cranial nerves. When these nerves escape from the brain or cord they are covered by all three membranes, the layers being most distinct along the optic nerves. Fluid injected into the subdural space may pass along the spinal nerves as far as the limbs. It is essential to realize this in order to appreciate how extensive is the surface exposed in leptomeningitis.

Internal hydrocephalus is often the result of closure of the foramen of Magendie. The cerebro-spinal fluid is rapidly reproduced after traumatic escape. External hydrocephalus, or accumulation in the subarachnoid space, is a condition frequently due to tubercular infection.

The *pia* is the vascular coat of the brain, supplied with an extensive network of fine nerve-fibres derived from the sympathetic and the cranial nerves, having intimate relations with the brain, to such an extent that leptomeningitis and encephalitis are almost inseparable. The nerve-supply to the cerebral membranes explains the severe pain of meningitis.

INJURIES TO THE SOFT PARTS OF THE CRANIUM.

In direct connection with what has just been stated above, it is well to emphasize that the venous communications between the exterior and interior of the cranium are numerous, and that the frequency of these anastomoses explains the ease with which extracranial infections are propagated within; in other words, these explain the frequency of septic mischief in the brain from external injuries.

Penetrating and incised wounds are frequent about the head, their prognosis *per se*, as well as their proper treatment, varying but little from that of such wounds in other parts, so long as the skull proper

and its contents escape injury. Hemorrhage from scalp wounds may be free, even fatal. The most dangerous hemorrhages occur from the temporal vessels. Penetrating wounds are short, and the periosteum and underlying bone are usually also injured. Such small articles as blades of penknives, particles of dirt, etc. will often be found when the parts are carefully inspected, a measure never to be neglected. Contusions of the scalp and skull are spoken of as subcutaneous, subaponeurotic, or subperiosteal, and are most frequent in the frontal and lateral regions. Ecchymoses following them may be extensive and discoloration may spread over a large area. In traumatic hæmatomata resulting from various injuries incision should be early resorted to should blood-clot fail to resorb.

TREATMENT.—In all head injuries the injured portion at least of the scalp should be shaved, by which cleanliness is promoted and examination facilitated. Wounds should be treated upon the general principles enunciated in Volume I. Sutures are often called for, though when the edges of a scalp wound are ragged it would be better not to suture them until all the injured tissue has been cut away and the wound carefully disinfected. All the cephalhæmatomata, no matter how extensive or deep, which lie outside of the bone are at all times amenable to incision when other treatment fails. Next to the immediate danger from failure to control hemorrhage, the greatest risk run by all of these cases is of failure to take proper antiseptic precautions in the beginning ; and of all these injuries, one may say that the fate of a patient lies in large degree in the hands of the man who first treats him. Untold numbers of deaths have been the more or less remote consequences of infection proceeding from wounds improperly treated at first.

INJURIES TO THE CRANIAL BONES.

All conceivable degrees of injury to the bones, from a trifling division of the periosteum down to most extensive denudation or mangling of the external table or the entire thickness of the bones, may be met with. These lesions may be spread over a large area or may be the result of penetrating wounds. In other words, we may have linear, penetrating, or large surface wounds with such injury to the scalp as perhaps to amount to a total loss of covering for the same. All of these, moreover, may be complicated by fractures of the bone at the point of injury, with or without brain lesions, or by other and more remote lesions.

In regard to most of these, it may be said that *non-penetrating injuries*, when promptly and properly attended to, have, for the most part, a favorable prognosis. Every *penetrating wound* of the cranium is a condition justifying grave prognosis, on account of the great danger incurred of infection. Other features of these wounds, with more in regard to prognosis and treatment, will be given under the head of Compound Fractures of the Skull, etc., with which they are usually connected.

It is necessary, however, to say in this place that penetrating wounds of the cranium are often received in a way which does not permit actual diagnosis, as, for instance, when received through the nose, the orbit, etc. Every wound whose history and appearance indicate that

penetration may have occurred should be, however, subjected to the most rigid scrutiny and care. Points of fencing foils, umbrella tips, etc. have been forced into the brain-cavity through the orbit and elsewhere, in a way which left little external evidence of the severity of the injury.

FRACTURES OF THE SKULL.

Following the anatomists, and for general convenience, these are divided into **fractures of the vertex,** of the **lateral region,** and of the **base,** the former being the most frequent, since the vertex is the most exposed. A fracture in a given region may be confined to that locality or may radiate widely or extend nearly around the cranium. Of all the fractures of the bony skeleton, those of the skull constitute about 2 per cent. Fractures of the *vertex* are, for the most part, due to actual violence, the force being often expended at the point of application or producing radiating fractures. Those which are limited to the neighborhood of the injury are spoken of as *direct* fractures, in distinction to

FIG. 7.
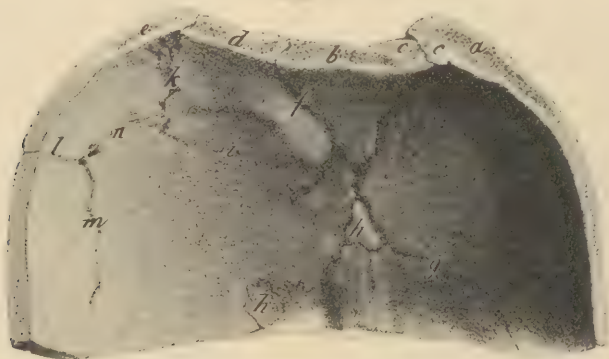
Multiple fractures with depression (Bruns).

which we have *indirect* or *radiating,* often producing remarkable results. Fractures may vary between the simplest crack or fissure, accompanied by but trifling brain-symptoms and never recognized, to the most extensive comminution and destruction of cranial bones which can be imagined.

Fissures are practically cracks in the skull, similar to those which may be seen in glass, and are not necessarily followed by the slightest displacement; nor is the entire thickness of the bone always involved, though in the majority of cases the internal table sustains more or less injury. Fissures are often spoken of as *linear fractures.* They may be straight or irregular, limited to one bone or involving several, single or multiple, and when radiating from a common centre are described as stellate.

Splintered or comminuted fractures refer to the formation of numerous bony fragments which are often more or less loosened, sometimes completely so, occasionally dovetailed together, and often driven in or depressed. Such fractures are direct. It is possible to have comminution without depression; the latter makes it the more grave condition.

Fractures with absolute loss of substance may be made by gunshot injuries or by any extensive splintering by a penetrating body. It is possible to have *fracture of one table without that of the other*, this being most often true of the external table. In isolated fractures of the inner table there is often dislodgement of small fragments which may injure the dura and possibly produce later epileptic or irritative disturbance. When the external table is chipped off the diploë is exposed, and this with its wonderfully fine venous communications opens up a wide area to infection and subsequent pyæmia.

Gunshot fractures are always depressed and almost invariably comminuted. The bullet of the modern army rifle possesses a great initial velocity, and the cranium struck by it will probably be disrupted into fragments, with instant death. The majority of gunshot fractures of the skull seen in ordinary civil practice are due to revolver or pistol bullets from weapons of the prevailing type of to-day. In these instances there will usually be penetration, perhaps with perforation of the skull, and the formation thus of one or of two compound fractures, the

Fig. 8.
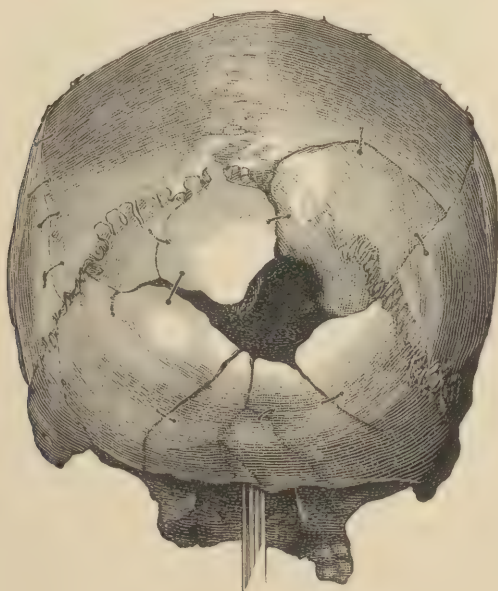
Gunshot fracture of skull (Helferich).

wound of entrance being always comminuted and depressed, while fragments of bone may be scattered along the course of the bullet, which may also carry in infectious material from without, such as hair, particles of hat, etc.

Whatever may be the wisdom of operating in other cases where there is room for doubt as to the proper course, there never is uncertainty as to the proper treatment of gunshot wounds of the skull, which *should be invariably subjected to operation*.

It will thus be seen that fractures of the skull may be *simple* or

compound, or *complicated* with other injuries, or *depressed*, without any reference to whether they are simple fissures or more extensive injuries. On the other hand, depressed and comminuted fractures may occur without being compound in a surgical sense, and with each one of these injuries there may be accompanying disturbance of the brain of any degree of severity, from the mildest concussion or shock up to rapidly fatal compression. Any imaginable complication of these head injuries is not beyond the bounds of possibility.

Fig. 9.
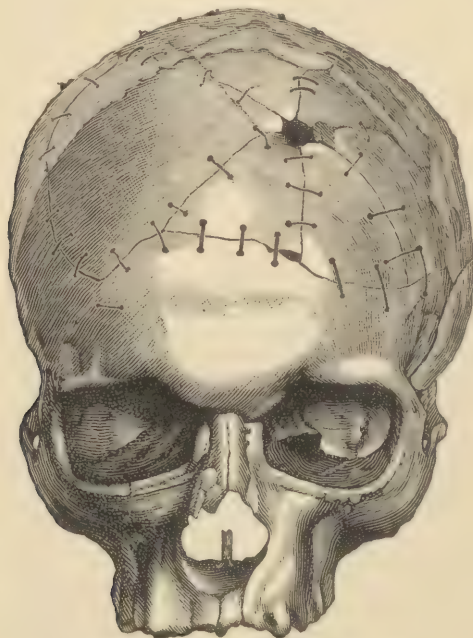
Gunshot fracture of skull (Helferich).

The essential features in explaining the *mechanism of fractures* of the vertex are the area involved and the violence of the impact. The skull is often surprisingly elastic, even in the oldest individuals, and fractures occur ordinarily when the natural limits of elasticity have been exceeded and bone-cohesion overcome. Children particularly suffer from depression without fracture, which formerly was never operated upon, but which is now regarded as calling for operation. On the other hand, certain skulls are *abnormally fragile* (see Fragility of the Bones, Chapter XXXV. Vol. I.), and, among the insane, may be found so porous and yielding as to be pressed out of shape without great difficulty. In injuries of slight extent it is enough that the skull be regarded as composed of an elastic substance, while for injuries produced by greater violence the skull is to be considered rather as a globe or arch possessed of high resistance and elasticity, whose shape will probably yield more or less before a fracture results. Much may be learned from such experiments as those of Felizet, who filled skulls with paraffin and dropped them from varying heights, and then divided the bone, to note in numerous instances that, although the bone had not been fractured, it had yielded at the point of impact to a degree producing a marked depression in the paraffin beneath. It is, then, certain from observation, as well as from a multitude of experiments, that after various injuries, especially to the top of the head, the shape of the skull is momentarily altered and its diameters affected. Many frac-

tures, then, are the result, as it were, of a *bursting force*, which may be shown by the fact that hair has been found included within closed fissures, as well as even the dura itself. Moreover, particles of bullets have been found within the skull without any visible opening through which they could have entered, showing that the bone has yielded under impact for a fraction of a second. It must also be remembered that in certain injuries to the head, as where a man is struck to the ground, there is injury at two points presumably nearly opposite.

Fractures of the skull, especially of the vertex, possess surgical interest mainly as they are accompanied by more or less evidence of *intracranial complications.* So long as there is no evidence of hemorrhage or laceration within, they are ordinarily regarded as a feature of the external wound with which they are usually found, and, unless there be comminution, depression, or some other good reason for operating, are covered over as the wound is closed, and are left to the natural process of repair by formation of minute callus or by the ossification of granulation-tissue.

It is absolutely unfair to contrast the results of the surgery of to-day with those of the pre-antiseptic era. Rules then enforced are now entirely abrogated, and the methods of to-day would have made our surgical ancestors protest most loudly. One respect in which we violate precedent is in our disregard, to-day, of the *periosteum* or pericranium. This is sacrificed without hesitation when found to be infected or torn or lacerated beyond capability of repair. A flap of scalp, it is known, will adhere as kindly to denuded bone as to periosteum, and we have even learned that skin-grafts can be applied and relied upon to adhere to this same bone—if not upon the first day, a little later when granulations have appeared. In the various plastic operations necessitated about the head we may also transplant flaps upon otherwise uncovered bone without the slightest hesitation. We have, furthermore, learned to treat fractures mainly in accordance with what we decide as to intracranial complications, or through what we can see either through the wound, if present, or through an opening intentionally made under antiseptic precautions for purposes of exploration. It is everywhere conceded to be better policy to remove fragments of bone whose vitality is uncertain, and to sacrifice ruthlessly any tissue injured or lacerated to such an extent that sloughing would probably follow, or so exposed as to have become necessarily infected.

DIAGNOSIS OF FRACTURES OF THE VERTEX.—In the absence of an open wound, and unless incision be made, this must often be conjectural. In the presence of a wound diagnosis is usually easy, enlargement of the wound to any reasonable extent being perfectly legitimate for purposes of examination. In case of a small puncture with suspicion of fracture it will be usually better to enlarge it sufficiently to permit the introduction at least of the finger and of careful inspection. With the finger and the eye we seek to detect differences in level, depressions, fissures, etc. Mistakes often arise from the formation of an exudate or a clot, by which a mere depression of the soft parts may be regarded as actual depression of the bone. Error occasionally arises from the existence of previous atrophy of the bone or any congenital defects in ossification of the skull; also in the skulls of syphilitic patients where disappearance of a gumma is often followed by absorption of the underlying bone. In every case of doubt it will be

wise to make exploratory incisions, of course under rigid aseptic precautions. These should not be made, however, unless the attendant is ready—*i. e.* has the facilities immediately at hand—for carrying out any further operative procedure that may be necessary, as elevation of fragments, removal of foreign bodies, etc. Areas of bloody infiltration often have abrupt margins which are calculated to easily deceive. In children, more especially, we often have a circumscribed bloody tumor which may contain cerebro-spinal fluid rather than pure blood. In some of these cases after exploration there will be found material resembling brain-matter, which, however, is not always such, although real brain-substance

Fig. 10.

may escape, such escape necessarily implying rupture of the overlying membranes. Should it be noted that the fluid used for irrigating and cleansing such a wound begins to pulsate, it will almost always mean connection with the cranial cavity, and, obviously, fracture. A suture should not be mistaken for a line of fracture. This mistake is more easy when Wormian bones are present. One should not forget that blood may be wiped away from a suture line, but not from that indicating fracture. It is not often possible to diagnose an isolated fracture of the inner table. It happened, however, once to Stromeyer to notice that so soon as an injured patient assumed the horizontal position he began to vomit, which nausea sub-

Depression of inner table (Bruns).

sided when he was placed in the upright position. On autopsy it was found that there had occurred a depressed splintering of the inner table with perforation of the dura : less irritation was produced in the upright position than when the patient was lying down, which accounted for his vomiting when in the horizontal posture. When a comminution has been produced it is always of prognostic value to find an unbroken dura, since so long as its integrity is undisturbed the prognosis is better than when the reverse obtains. Prolapse of brain-substance is always a most serious complication. Escape of cerebro-spinal fluid is relatively rare.

TREATMENT.—Treatment comprises attention to the local injury and the suitable dealing with the condition of the brain within when injured. The treatment of *simple fractures* is, for the most part, *expectant.* In the absence of indication for operation it should be exceedingly simple, and should consist of physiological rest, aseptic dressings, ice applications to the head, the administration of such laxatives, diuretics, antacids, etc. as may be necessary to favor free excretion and to guard against auto-intoxication. Whenever there is reason to suspect a depression, exploratory incision at least should be made. *Actual depression*, whether the fracture be compound or not, *calls always for operation*, the opinions of

surgeons of past generations to the contrary notwithstanding. This course is justified by the numerous instances in which later consequences have been noted, such as traumatic epilepsy, insanity, etc.

Compound injuries call always for operation of some character, including the removal of loosened splinters, the elevation of depressed bone, the removal of all foreign matter, the checking of hemorrhage, the excision of bruised and lacerated tissue, and the proper closure of the wound, with or without drainage according to circumstances.

In many serious and lacerated cases it is inadvisable to close the wound with the view of attempting primary union. It is much better to pack it with gauze and temporarily close it with secondary sutures. All of these surgical measures should be seconded by efforts which every judicious surgeon will always put into practice—namely, *physiological rest* (quietude of the head, which may even be enforced by the posterior plaster-of-Paris splint to the head and neck), attention to the *primæ viæ,* the avoidance of transportation, the prevention of auto-intoxication, etc. The best judgment will often be called for in decision as to the amount of bone to be removed, the wisdom of opening the dura when not lacerated, of examination of the brain with the exploring needle, the matter of drainage, the time during which it shall remain, etc. With reference to all these matters exact rules cannot be given, but every case must necessarily be decided upon its own merits. When drainage is made in recent cases it is usually sufficient to drain the scalp wound. Only in cases where there is probability of meningeal infection does it pay to deliberately attempt to drain the dural cavity. This is perhaps better done with gauze than with drainage-tubes.

Skull-fractures where the injury is limited to a small area are now treated according to a bolder method than was in vogue a number of years ago, especially in cases where depression is recognized. I believe thoroughly in *careful and judicious operating in every case where distinct depression can be made out,* as well as in every case where indications point to injury of parts within the bone. The statistics of trephining in the pre-antiseptic era are valueless as arguments in this consideration. If done according to strict aseptic precautions and if good surgical judgment be used in every respect, the operation is *per se* almost devoid of mortality, and should not be regarded as a last resort, but rather in such cases as a first one. I have myself seen so many instances of later untoward consequences resulting from delay, which corroborate the experience of others, that I would not be misunderstood in this matter. My advice might perhaps be summed up in the following words: *Where there are no brain-symptoms and no skull-symptoms in fractures of the vertex leave the case alone; when either of these is present, especially the former, it will always be wise to operate.*

The question of how far interference, or how much of exploration, may be permitted when the brain itself is injured is another to be decided only upon its merits. So far as gunshot injuries are concerned and the removal of missiles, it will probably be the safest rule to follow that only foreign bodies which appear on or near the surface or which can be easily or definitely located call for removal. So far as other interference with the brain is concerned, it must be decided mainly on the brain-symptoms and upon the special localizing symptoms, all of which are yet to be considered.

Fractures of the Base of the Skull.

In most of these fractures the violence is applied at some more or less distant point, and, by transmission through the arch-like structure of the skull, expends itself in fissuring or comminuting the base. The most frequent location of the indirect injury is upon the convexity. The mechanism of these fractures, indirect as most of them are, has been a vexed problem for many centuries, but has been cleared up mainly within the present century. Felizet has shown, for instance, how the handle of a hammer may be forced into its head by striking it in either one of two different ways, and has compared the mechanism of basal fractures to this fact. The secret of basal fractures probably resides in the elasticity of the skull, which varies within wide limits in different individuals, and which breaks, as do the ribs and the pelvis, at points more or less distant from that at which the injury occurred. Were the skull

Fig. 11.
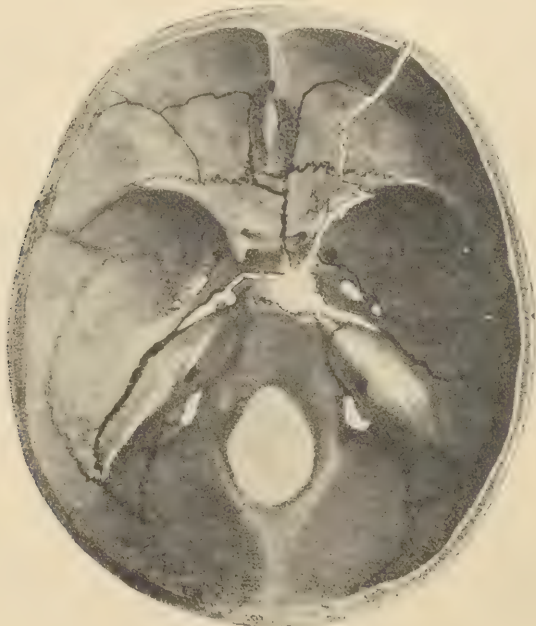
Fracture of base of skull (Bruns).

everywhere equally thick and elastic, there would be much less variation in these fractures, but we know that lacerations frequently extend between the most resistant parts ; and when violence is applied upon the forehead we commonly find that the resulting fissure extends between the crista and the wings of the sphenoid upon the same side in its course toward the base ; that when the lateral region of the skull is injured the fissure commonly extends between the sphenoidal wings and the occipital bone ; and that when the occipital region receives the first injury the fracture lies usually between the pyramid and the occipital crests. The analogy between fractures of the skull and cracks made in nutshells (cocoanuts, etc.) when struck with a hammer is too self-evident to be lost

PLATE I.
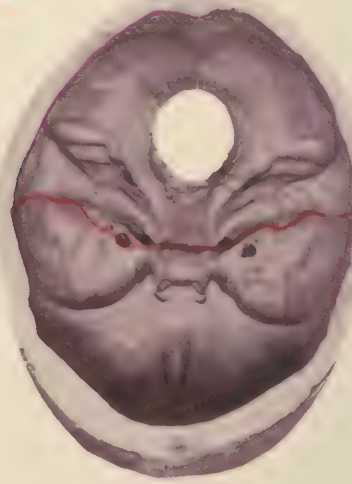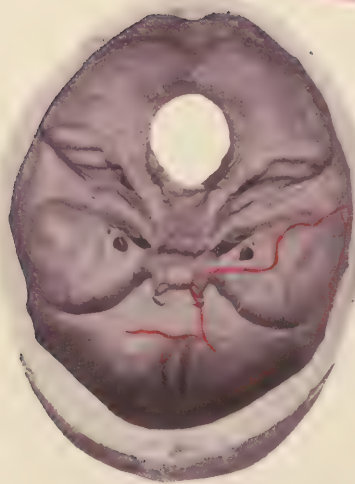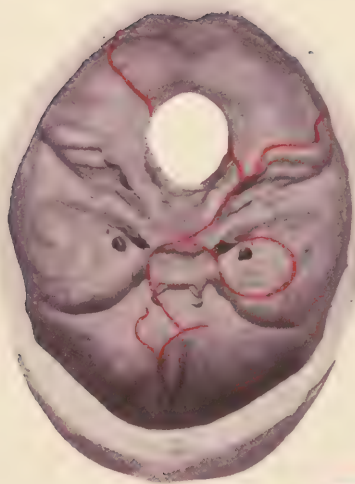
Fractures of the Base of the Skull.   Illustrative Lines of Fissure
or Fracture are printed in Red.

sight of. Many years since the French introduced the term *fracture by contre-coup* (counter-stroke)—a practical admission of the occurrence of fracture at a point more or less opposite to that struck.

In 1884, Aran formulated the following conclusions, which will probably stand to-day undisputed :

1. The great variety of indirect fractures of the base (by so-called contre-coup) are in reality fractures propagated from vertex to base—*i. e. fractures by irradiation.*

2. Fractures reach the base from the vertex by the shortest anatomical route, traversing fissures in their course.

3. There is a relation between the region of the skull first injured and the seat of the basal fractures. Accepting the anatomical division of the inner basal surface of the cranium into three fossæ, it may be said that lines of fracture occupying either one of these fossæ are likely to be produced by violence applied to the corresponding region of the vertex.

There is, however, no certainty about these fractures, and to spend further time in this connection in studying these minutiæ would be of little avail to the student. It will be enough to add, then, that extensive fissures of the vertex are almost always extended to the base of the skull, while the reverse is seldom true. There are doubtless also many cases in which a bursting force compromises the bone rather than mere radiation of unexpended violence ; but so long as skulls conform to no fixed mathematical figures nor proportions, but are composed of bones varying in shape, density, and strength, it will be impossible to formulate any laws which are comprehensive enough to be satisfactory. Fractures in the posterior fossa occur for the most part through violence applied posteriorly and from below. There is a ring-form of basal fracture produced mainly by the impact of the vertebral column, as when an individual falls upon the head, the weight of the body forcing the cranial base in upon the brain. Fractures of the anterior fossa may involve the roof of the orbit ; even facial bones may participate in the injury. These considerations are not without importance, since if a patient presents symptoms of injury of the petrous bone, and if these be accompanied by injury to the lateral region of the skull, we are in position to make a diagnosis of fracture of the middle fossa. (*Vide* Plate **I.**)

By all means, the majority of basal fractures are mere *fissures which open and close instantly upon their production*—close so quickly, in fact, as scarcely even to include blood between the broken bony surfaces.

PROGNOSIS.—The majority of basal fractures are fatal, either because of injuries to the brain, or of hemorrhage or violence along the nerve-trunks, or from infection extending along the newly-opened paths. Other things being equal, the longer the fissure the greater the danger, particularly so when it takes its origin in the vertex, and because of greater ease of infection. *Air-infection* may incur in any basal fracture by fissures extending into the various air-containing cavities—nose, ears, sinuses, etc. They are then practically compound, though invisible. The general prognosis will depend, first, upon *the injury to the cranial contents ;* second, upon *the possibility of infection.* Statistics are absolutely unreliable, although always possessing interest. Numerous museum specimens show the perfection with which bony repair may occur and the admirable way in which compensation is afforded for

defects. Suppuration after basal fractures is mainly that due to puru-
lent basal meningitis, in which case the brain-symptoms dominate in the
clinical picture, while the appearance of a single drop of pus in the ear
or upon the surface is of the greatest significance. The *conversion of a
serous outflow (e. g.* from the ear) *into purulent fluid* is also *pathognomonic.*
Various *paralyses*, principally of the cranial nerves, may follow this
injury and prove temporary or permanent. Diagnosis is often made by
the study of these special nerve lesions.

DIAGNOSIS.—The most significant diagnostic features are—

1. *Spread of blood from the point of fracture until it appears as an
ecchymosis at certain points beneath the skin.* This will occur early in
some cases, late in others. It may appear beneath the *skin* or beneath
the *conjunctiva* or other *mucous membranes*, even in the pharynx.
Occurring about the *mastoid*, it implies fracture of the middle or pos-
terior fossa ; about the *eyelids*, of the anterior fossa. Beneath the bulbar
conjunctiva, it means extravasation along the optic sheath, probably
from within the dura. In fractures of the posterior fossa it will come
to the surface of the neck, but only after two or three days. The
ecchymoses about the lids or orbits occurring after two or three days
mean more than those occurring within these days, since the latter may
be caused by external bruising. The globe of the eye may be pushed
forward by blood accumulating within the orbit. *Exophthalmos* thus
produced is therefore most significant, though not common.

2. *Escape of serous fluid, blood, or brain-substance from the cavities
of the skull.* Hemorrhages from this cause occur most often from the
ear, the petrous bone being tunnelled with various canals through which
blood may thus escape. One should, however, assure himself in every
instance that the blood is really escaping from the ear, and not from
some trifling wound of the external soft parts, the soft walls of the
meatus, or the tympanum itself. Profuse hemorrhage can probably only
come from a basal fracture. Escape of *serous fluid* is usually noted as
a sequel to hemorrhage, although it may begin almost immediately after
an injury. Rarely more than twenty-four hours elapse before it begins
to flow, if at all. The quantity of fluid discharged is sometimes aston-
ishing. It may occur in frequent drops or during expulsive efforts, like
coughing, or may ooze in such a way as to be insensibly collected by the
absorbent dressings. In average cases the amount in twenty-four hours
is from 100 c.c. to 200 c.c. : 800 c.c. have been noted in occasional
instances, and in a very few still more.

Cases characterized by escape of fluid from the ear usually belong in
one of the following categories :

(*a*) Those in which there is copious and continuous discharge setting
in early after injury, in which one may with reason suspect a fissure of
the petrous bone extending into the subarachnoid space.

(*b*) Cases where the escape does not occur until the second day, and
which are preceded by hemorrhage.

(*c*) Those in which a small quantity of fluid trickles slowly away,
either with or without previous hemorrhage. Here diagnosis is uncer-
tain, but prognosis is good.

In other instances the fluid may escape through the Eustachian tube
into the pharynx, whence it may escape by the nostrils or be swallowed.

The escape of brain-substance is rarely noted, and obviously implies such serious injury as to make the prognosis of the worst.

3. *Disturbance of function along particular cranial nerves, paralysis of which is often produced by fractures of the base, particularly those involving the foramen of exit of the nerve involved ;* in which case the nerve may be lacerated or injured by the fragment of bone.

4. In addition to these distinctive features there will be in the majority of instances *brain-symptoms,* either of *contusion* or *compression,* varying in severity within all possible limits, but adding their weight to the value of the testimony. These will soon be considered by themselves.

Other and unusual signs of basal fracture may occur, such as communication between the cavities of the petrous bone and the mastoid cells, and leading to the formation of *pneumatocele,* or *emphysema* of the overlying soft parts, observed mostly about the orbits, where the nasal cavity is as well involved.

TREATMENT.—The treatment of basal fractures is mainly *symptomatic.* The first effort should be to make antiseptic all those parts of the skull involved, which means to shave the scalp ; to thoroughly cleanse and irrigate the external ear and the auditory meatus, using a head mirror and ear speculum for this purpose, if possible ; to tampon the meatus with antiseptic cotton ; to provide a copious absorbent dressing for such fluid as may escape, and to change this frequently ; to cleanse the nasal cavity so far as possible, as well as the conjunctival sac when necessary, for all of which the peroxide of hydrogen is most serviceable. All of this should be done promptly, while at the same time studying the patient for evidence of brain injury or of involvement of special nerves. By the time these measures are thoroughly carried out a decision at least as to the necessity for immediate operation should have been reached. Evidence of brain-compression wanting, and in the absence of external or compound injury, the patient may be left at rest, with *cold applications* to the head and active purgation. In many of these instances benefit follows the application of a number of *leeches* to the mastoid region and to the occiput. Operation is called for later only when brain-symptoms supervene, these consisting for the most part of evidences of compression, either from blood or from pus, since compression from other causes must have been acting at the time of the first examination, and should have been recognized at that time. When direct fractures are evident the possibility of the entrance of foreign bodies must be also remembered. Thus, penetrating fractures of the base have occurred through the orbit as the result of accident or assault, and such weapons or implements as foils, ramrods, drumsticks, canes, umbrella points, etc. have been known not only to penetrate into the brain, but perhaps to leave some portion of their substance—*e. g.* a foil tip or an umbrella tip—within the cranium after their withdrawal.

These are cases which call for special and delicate manipulation not comprised within the ordinary treatment of basal fractures. They are usually compound fractures of the base, and are mentioned here mainly to illustrate the judgment and surgical acumen that may be called for in many of these instances. These are, of course, cases justifying more or less extensive incision and exploration, as well as necessitating the removal of a foreign body when present, since its remaining would in all probability entail either a prompt meningitis or later brain-abscess.

Separation of sutures, known also as *diastasis* of the same, is the occasional result of injury instead of, or complicated with, fissures or other fractures. It is the result of violence, and is virtually a specific form of fracture, from which it differs in no essential particular. Diastasis can only take place along lines of previous suture, but it is possible that Wormian bones may be thus loosened. Sutures thus separated ordinarily heal by fibrous repair rather than osseous union. Diagnosis is ordinarily possible only as they are exposed to view, although displacement in the middle line or along known suture lines may be perhaps regarded as diastasis.

The TREATMENT differs in no respect from that of other fractures.

Injuries to the frontal sinuses occasionally complicate fractures of the skull. These sinuses vary exceedingly in different individuals; are rarely truly symmetrical; are not found in the very young; they connect with the nose in such a way that emphysema of the frontal region is quite possible, while air may even be blown beneath the periosteum or may communicate with the interior of the cranium. In wounds of the frontal region the sinuses are occasionally opened—a fact of importance, since infection of the Schneiderian membrane may occur and endanger life, mainly because of the retention of infectious products within its cavities. Moreover, by such wounds the *ethmoid* may also be injured. Pus which escapes from these sinuses and from the ethmoidal cells is usually thin and bad-smelling. Long continuation of suppuration after such injuries probably means necrosis and formation of sequestra.

INJURIES TO THE BRAIN AND ITS ADNEXA.

With the recognition of certain portions of the brain whose function is now generally recognized and described, as well as with the more exact knowledge regarding the entire encephalon, the outcome of many recent studies, the teaching of the past with regard to the nature of various brain lesions has been essentially modified. Especially is this true with regard to the distinction formerly emphasized as between *concussion and compression*. In discussing brain injuries we must, first of all, distinguish between traumatic disturbances of the entire endocranium and localized injuries to the brain or particular vessels and nerves entering into its composition. With regard to the first, it is possible that the entire blood or lymphatic circulation within the cranium may be affected in such a way as to influence its nutrition and function, by which means activity and function are mildly or seriously perverted. The immediate effect of severe injury to any part of the body is reflex vasomotor spasm, which constitutes the essential feature of the condition known everywhere as *shock*. It is this condition, with its strong local expressions, which used to be known as *concussion of the brain*. When studied upon its merits, it is found to be *indistinguishable from shock* produced by injuries to other parts. It will be correct, then, to make the general statement that the condition for so many years taught and recognized as concussion is but shock following injury to the head. This makes no further demands upon the question of pathology than those prompted by any traumatic disturbance.

Through the mechanism of the cerebro-spinal fluid rapid alterations of pressure and of the volume of the brain are produced. There is an easy path between the inelastic cranial cavity and the exceedingly elastic and accommodating spinal canal, which latter serves as a reservoir for the fluid which may be pressed out of the cranium when brain-pressure is increased. And, while the subdural and subarachnoid spaces are each of them absolutely closed sacs and do not communicate one with the other, there, nevertheless, is ample accommodation within each to permit a constant equilibrium of pressure under ordinary circumstances, as between the spinal cord and the cranial canal. The brain expands in volume with every systole of the heart, while with every diastole it contracts. Its size is, moreover, modified by the motion of respiration. Under these extremely accommodating conditions it is scarcely credible that external injuries which leave no internal marks of violence should do anything more than disturb the equilibrium of fluid distribution.

CONCUSSION OF THE BRAIN.

We inherit the term *concussion* from the earlier masters of our art, by whom, however, it was used in a much broader sense than of late. Its modern significance was given to it by Boirel, who made it apply to a group of cerebral symptoms the result of injuries not accompanied by fracture or perceptible laceration of vessels—symptoms varying in intensity and duration.

In 1705 the subject was first studied anatomically, and then by Littrè, whose inferences were natural from insufficient investigation, and who ascribed trifling alterations of brain-tissue to the inevitable results of serious injury to the skull. Later, Petit formulated the statements which until recently have been generally held, that as the result of external violence vibrations are produced which are continued to the brain-substance and cause oscillations or other trifling molecular changes. There has always been this difficulty, however, that concussion was rarely followed by death—that the injuries which were followed by recovery could not be accurately estimated, while after those which were followed by death the brain was almost invariably found the subject of at least minute disturbances, such as capillary hemorrhages, trifling lacerations, etc. The physiologists have taught us that the most minute injury—at least in certain parts of the brain—is enough not only to disturb, but to destroy, function; and we can maintain with probable accuracy that in so-called fatal cases of concussion we have to do with something more than mere molecular disturbance without discoverable effect. Moreover, from mere oscillation we have the right to expect that after the lapse of a certain time there should be complete or almost complete repair; in which hope, however, we are disappointed so far as clinical experience goes. And so it has happened that the theory of communicated vibrations, so long unchallenged, has of late been almost completely abandoned, at least in those cases which are followed by long-continued or permanent disturbance. Experimentation upon animals has done a great deal to lead to this change of view, it being found that any injury to the head which seriously disturbs function of the brain gives appearances of congestion of membranes or of the substance of the brain, with minute vascular ruptures, trifling lacerations, etc. The most valuable researches in this connection have been conducted by Duret, who has apparently proven that when an impression is made upon one side of the skull, even though it be instantaneous, produced by a blow, it is followed by elevation at a point opposite, permitted by the elasticity of the bone. There occurs also a violent precipitation of the liquid contained within and around the brain in the direction of the injury, with damage to the vessels and even the substance of the brain. These separate traumatisms he divides into three stages:

    a. Of excitation;
    b. Of paralysis;
    c. Of reaction;

during the first of which there is a tetanic condition of muscles, often with violent expulsion of urine and fæces, increase of vascular pressure, and irregularity of the heart. This stage, sometimes only a few seconds in duration, is succeeded by the

paralytic stage, marked by vascular relaxation, insensibility, rapid respiration, temporary paralysis of muscles, etc. The third stage is characterized by elevation of temperature, and often by mental excitement, merging even into delirium or mania.

Our present position is practically this: The possibility of pure concussion of the brain—*i. e.* disturbance of brain function without gross mechanical lesions—is admitted, but its general frequency is denied. When present it must either pass away quickly, the condition being equivalent to that called "stunning" by the laity, or, if it assume distinct form, its *signs and symptoms* are indistinguishable from those of shock, consisting essentially of rapid and feeble pulse, quick and shallow respiration, pallor of the skin, copious perspiration, complete or partial unconsciousness, muscle inco-ordination, with lack of sphincter control, occasional vomiting, the pupils usually reacting to light.

The TREATMENT for this condition is essentially that for shock, plus whatever may be called for in the way of attention to injuries about the head—*e. g.* sewing up a scalp wound, etc.

CONTUSION.

The condition of *shock* (*cerebral concussion*), when of pure type, passes away with reasonable promptness, especially when aided by surgical treatment. *Anything which persists* in the way of muscle-paralysis, disturbance of function of nerves of special sense, or *other sign of any importance*, indicates something more than mere vibratory disturbance: it implies mechanical lesion which could be perceived by the eye were the parts exposed, and constitutes the condition now generally known as contusion. This implies the existence of trifling exudates or hemorrhages, which require not only absorption, but even cicatrization. *Contusion pure and simple* differs from ordinary *laceration* as a contusion elsewhere may differ from a wound. It cannot be separated, however, from conditions in which there are minute separations of continuity and actual lacerations. It may be divided into three post-mortem forms: *general hyperæmia*, with or without œdema; *punctate* or *miliary hemorrhages;* and *thrombosis of minute vessels*, which may occur separately or together. Moreover, there may exist similar lesions in the meninges, constituting *meningeal contusion.* Ordinarily, minute vessels of the pia are ruptured and blood is effused in small and thin patches over various parts of the brain. The so-called *compression apoplexies* of certain authors are inseparable from the conditions above described. Such minute blood-clots are only to be distinguished upon very careful sectioning of the brain, and are found most often in the region of the medulla and along the floor of the fourth ventricle. They are probably caused by the forcing into the fourth from the lateral ventricles of the fluid contained in the latter.

SYMPTOMS OF CONTUSION.—When the ordinary symptoms of shock which follow all severe injuries to the head, especially when the deep lesions are not too severe, fail to disperse in a short time under proper treatment, and when, in particular, new and irregular symptoms are superadded to those of shock alone, we have every reason to think that the intracranial condition is one of contusion rather than of shock. When, for instance, mental agitation changes into delirium, when the

rapid, feeble pulse becomes stronger and slower, the respiration deeper, the limbs moved in inco-ordinate ways, the speech disturbed from muscle inco-ordination, the patient selects wrong words, or when the mental condition becomes more serious and stupor or coma takes the place of delirium, while external irritants have less and less effect, and when the pupils gradually enlarge while failing to respond to light,— we may say that the *condition of contusion is making itself apparent.* If along with muscle-uncertainty there be also muscle-spasm or rigidity, with fixation of the fingers in the athetoid position, the evidence to this effect is increasing. If with all this the thermometer fails to show that an active inflammatory condition—*i. e.* meningitis—is prevailing, the diagnosis may be regarded as certain. Error may possibly arise when there are evidences of alcoholism. Coma following head injury ought not to be ascribed to the *alcoholic condition* except by the strictest process of exclusion. Temperature alone will be of the greatest service in this direction, since in *alcoholism* it is usually *subnormal.* In *apoplexy and non-traumatic hemorrhages* it is also usually *subnormal at the commencement* of the attack, rising to normal, and remaining there if the patient recover, but *continuing to rise in cases where the prognosis is bad.*

The TREATMENT of brain contusion must be managed largely in response to special symptoms. Physiological rest, attention to scalp wounds, fractures, etc., shaving of the scalp, application of ice to the head, with such stimulation to the heart as may be necessary in extreme cases by subcutaneous administration of strychnia, atropine, etc., by local fomentations over the epigastrium, or by immersion in a hot bath when surroundings permit it,—these in a general way constitute most of the methods of treatment in contusion. When only symptoms of diffuse and minute lacerations can be recognized, the use of the trephine is impracticable, even unjustifiable, save when indicated by some external marking—*i. e.* compound fracture or the like. When *localizing symptoms* are present the trephine is, of course, called for. When the skull injury is recognized as a basal fracture, venesection or the application of leeches behind the ears will be most serviceable. In every such case there is the greatest necessity for *regulating the excretions* and preventing auto-intoxication. For this purpose diuretics and laxatives must be used, often in conjunction with intestinal antiseptics. The catheter should be resorted to whenever indicated by the condition of the bladder, which should be carefully watched. As the days go by and patients lie more or less helpless and inert, the greatest care should be exercised for the prevention of bed-sores. When, still later, patience is tried to the utmost because mental inertness, muscle-rigidity, etc. fail to disappear, I would advise the use of potassium iodide internally, having seen great benefit from its use in many cases, although acknowledging that it is given on purely empirical grounds.

Brain-pressure or Compression.

That the cranial contents—brain, blood, lymph, and cerebro-spinal fluid—completely fill the cranial cavity has been already amply shown, as well as that there is no room for anything in the shape of a foreign body without seriously affecting the equilibrium between the brain and

the contents of the spinal canal. When, however, any foreign substance exerts pressure upon the brain, the results are invariably the same, be this substance what it may, and *compression signs are always the same, no matter what the compressing cause*. Reduction in size of the cranial cavity—*i. e.* compression—may be produced—

1. By altering the circulation of its surroundings (*e. g.* depressed fractures or by direct pressure);

2. By increase in the quantity of cerebro-spinal fluid or of the volume of the brain, which latter may be produced by œdema, by serous exudate, or by actual hypertrophy;

3. By foreign bodies, which may enter the skull from without;

4. By pathological conditions—collections of blood or pus, tumors, etc., which may be produced either from the brain-substance, its containing bone or membranes, or its vessels.

In every one of these conditions the size and tension of the brain are affected. *The cerebro-spinal fluid is mainly involved in acute, not in chronic, conditions.* A very slow reduction of the diameters of the skull produces such slow alterations of pressure as to cause a minimum of disturbance. So far as compression from traumatic influences is concerned, we distinguish mainly between—

1. Compression by extravasation of blood;

2. By fractures of the skull with depression, or by foreign bodies penetrating from without;

3. By products of acute infectious inflammation due to septic infection from without.

The result common to all of these is *increase of intracranial tension*, and its consequence is a less rapid flow of blood and an altered blood-supply to the brain and its membranes.

Experiment has completely established that in compression of the brain cerebro-spinal fluid is forced by pressure into the spinal canal, whose membranes are more elastic, and which thus help to accommodate it; but it has been clearly established that compression of the brain by one-sixth of its volume of any material is essentially fatal, and that much less is at least serious. That fractures with depression produce sometimes serious, at other times trifling, symptoms is due largely to the varying accommodation of the spinal canal. Both experiment and observation alike seem to confirm the view that consciousness pertains to the cortex as a whole, and that unconsciousness is an inhibitory or paralytic condition which is produced in compression.

Temperature is a matter of great importance in studying compression and foretelling its consequences. Elevation of temperature is an early, continuous, and constant symptom in these cases. If temperature be subnormal and subsequently rise, prognosis is bad. Variations of temperature are more reliable guides than conditions of consciousness. As Phelps has remarked, in no condition except sunstroke is temperature so uniformly high as in cases of serious encephalic lesions.

SYMPTOMS.—As indicated above, the symptoms and signs of compression are practically identical, no matter what the compressing cause. When this cause acts instantly there is no time afforded for differentiation, but when it occurs slowly we note the following symptoms, and about in the order as here presented: Irritability or restlessness; visceral disturbances; pain; intense cephalalgia; congestion of the face; narrow pupils; augmented pulse, often seen in the carotids. If compression

occur more rapidly, torpor quickly succeeds erethism, after which patients vomit, have convulsions or at least convulsive motions, speech is disturbed, and stupor comes on, from which they neither awake nor can be awakened until the compression is relieved. All of these indications refer to involvement of the cortex, which is generally regarded as the seat of consciousness as well as of projection and imagination. During the night of the senses produced by pressure upon the cortex only the automatic basal apparatus and that of the spinal cord continue in more or less disturbed operation. Of all the general functions, consciousness vanishes first and returns among the last. When intracranial pressure has reached a certain point, epileptiform convulsions result, varying in intensity, affecting all the limbs, and terminating perhaps with rigidity. These are an expression of high pressure. Similar convulsions occur in various head wounds, explanation for which is the result of pressure, which, though not extensive, may produce alteration in the circulation with its disastrous consequences. The later and *constant evidences of compression, and those which in aggravated cases supervene at once*, are reduction of pulse-rate, due to the action of the pneumogastric, which suffers first an irritation and later a paralysis. The pulse becomes not only slackened, but full; the respiration-rate is correspondingly reduced, so that breathing during coma is deep, slow, and often stertorous. This feature of stertor is an expression of paralysis of the palatal and pharyngeal muscles, which flap, as it were, in the air-current. Vomiting, which may occur before brain-tension has risen high, is not met with in the most serious cases. Coma is absolute, and nothing can arouse the patient.

Along with these signs, the most important other indications are the *paralyses*, which may consist of monoplegia, hemiplegia, or paralysis of individual muscle-groups according as pressure is made upon a limited area or upon an entire hemisphere. By the division of the cranial cavity by the falx and the tentorium it is divided into three chambers, in any one of which pressure may be more manifest than in the others. Nevertheless, a serious compressing cause will affect the tension of the cerebro-spinal fluid and produce general expression of pressure. The *pupils* often vary, and responsiveness to light is occasionally noted. Nystagmus and ocular rotation may be occasionally seen. Choking of the optic disk is also a frequent phenomenon, to be recognized only upon ophthalmoscopic examination. This is due to pressure in the subdural and subarachnoid prolongations along the optic nerve. In milder cases of chronic compression disturbances of vision are of very great clinical importance. These pertain especially to diagnosis of hydrocephalus and of brain tumors. When they occur immediately after injury, and remain, they depend upon laceration or other severe injury of the optic nerve. Those which quickly disappear depend mainly upon pressure of blood, which is reabsorbed, while those which are later in their appearance depend upon later intracranial complications. A unilateral lesion of the optic nerve depends most often upon injuries to it within the optic canal. When the lesion is bilateral the cause lies deep. General paralysis may be of the type of hemiplegia, single or double; *i. e.* by " double " I mean paralysis of the entire voluntary musculature of the body, which necessarily implies serious, too often fatal, hemorrhage.

PROGNOSIS.—This depends in large degree upon the nature of the compressing cause and of the possibility of its removal. While the nature of the same may ordinarily be determined, how much can be accomplished by way of removal may often not be foretold before the operation at which this should be attempted. In every acute case it is desirable to make this attempt early, since high pressure, which may be borne for a few moments, is fatal if continued. Compression to any serious degree, left unattended to, is usually fatal. So soon as paralysis in circulatory and respiratory centres is apparent the beginning of the end is at hand. Another reason for hastening operation, when indicated, is that acute softening of brain-tissue comes on promptly, as well as *general cerebral œdema*, which has destroyed many a patient from the **second to the fourth day after injury**.

When the pressure is localized, especially upon a limited area, this may suffer intensely, and the balance of the brain to a minor degree. So soon as this local pressure be relieved and circulation restored resumption of function is quite possible. Incomplete paralyses are the final results of extravasations, which often seem to be localized with sufficient accuracy to warrant operation. In some instances the brain appears to acquire tolerance for pressure when not too serious. This is shown by recovery, especially of children, after injuries which have left them unconscious for days. (*Vide* Plate II.)

TREATMENT.—The treatment of compression is summed up in one phrase—*i. e.* to remove the cause when possible. The only cases in which this rule may be safely disregarded are those where the attempt to remove the cause means more danger than to leave it unremoved. This is not true, however, in the ordinary cases of bone depression, meningeal hemorrhage, etc. Before operation, however, or as a substitute for it in cases of minor severity, it may be well to assist venous outflow by *venesection*, by which blood-pressure is reduced. In these cases this may well be done from the temporal veins or external jugulars, with the patient in the semi-upright position. Drastic purgatives may also be employed in order to utilize intestinal outpour as a stimulation to resorption of cerebro-spinal fluid. The physiological action of cold (ice-bags) may also be secured for the purpose of contracting the cerebral arteries. But all these measures are only to be resorted to when there is uncertainty as to the wisdom of operating, since when operation is clearly indicated it should be done at once, and *should take precedence of everything else*. This operation means ordinarily the procedure to which the now general term trephining has been applied by common consent, and comprises any measure by which the skull is opened at a suitable place and the dura or the underlying cortex exposed to such extent as to permit removal of the compressing cause. Whether the opening be made with trephine (annular saw) or with the straight or revolving saw, with bone-chisel, with bone-forceps, or with anything else is a matter of choice on the part of the operator. So, too, removal of the compressing cause should include the elevation of depressed bone, the removal of dislodged particles as well as of all foreign bodies, the cleaning out of blood-clot, the checking of hemorrhage, and the closure of the wound, with or without drainage or counter-opening at some other part of the skull, as may seem wise in special cases. This entire procedure comes now under the name of trephining, and must be painstakingly gone through with in most instances.
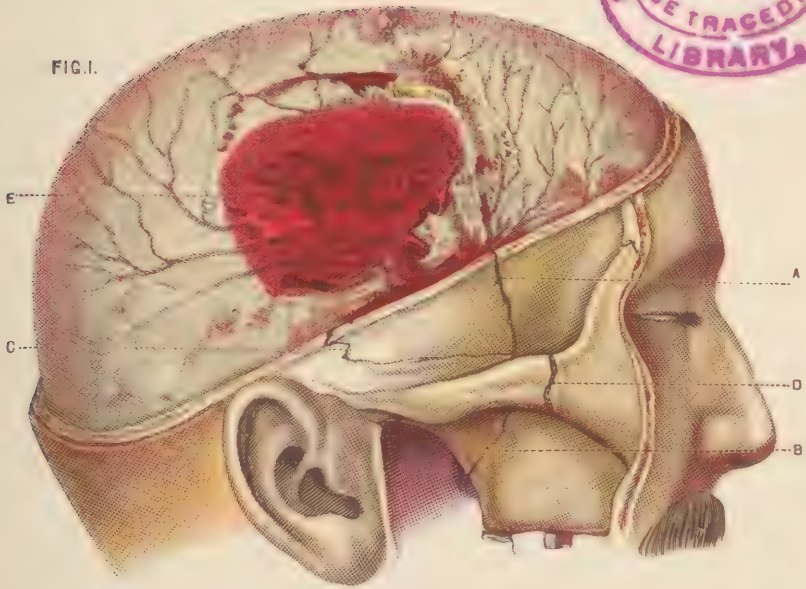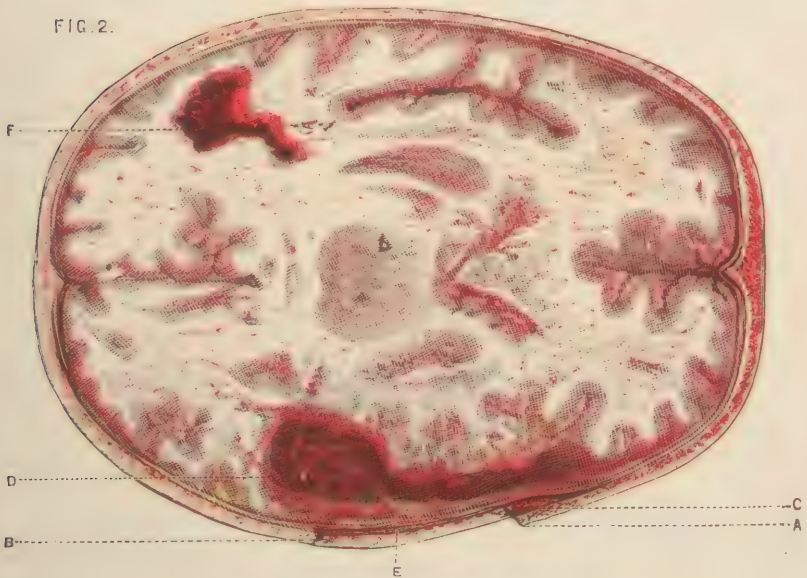
PLATE II.

Fig. 1.—Compound Fracture of Cranium, with Depression; Fracture of Bones of Face; Extradural Clot from Rupture of Middle Meningeal Artery.

Fig. 2.—Horizontal section of same, showing Depressed Fracture of Bone; C, Extradural Clot; D, Laceration of Brain-substance, with extensive Intracerebral Clot; F, Same condition produced by *Contrecoup*. Punctate Hemorrhages and Minute Lacerations at Numerous Points, characteristic of *Contusion* of the Brain. (Anger.)

The operative manœuvres will be discussed by themselves in another portion of this chapter.

INJURIES OF INTRACRANIAL VESSELS AND SINUSES.

Intracranial hemorrhages may occur—

a. From external sources through the broken bone or between it and the dura (extradural);

b. Beneath the dura, between or into the membranes (subdural);

c. Into the brain-substance proper or the ventricles (subcortical or intraventricular).

The vessels whose injuries are most often under consideration are the *meningeal arteries,* the *sinuses,* the *small vessels of the membranes,* and, in very rare cases, the *internal carotid.* The arteries, like the sinus-walls, may be ruptured either by substances forced in from without or by sheer laceration. The *longitudinal sinus* is most liable to injury from without. When this sinus is exposed it may be dealt with either by suture if the wound be small, or by ligation, or by tamponing with iodoform gauze.

FIG. 12.

Compression following hemorrhage from the middle meningeal artery (Helferich).

Hemorrhage from this source is ordinarily not difficult to check. Fatal air-embolism has resulted through an opened sinus not properly plugged. The other sinuses are very rarely injured, as by gunshot wound, fracture of the base, etc. The sinuses have also been injured by compression of the skull during parturition. Bleeding from the sinus is usually indistinguishable from that from a meningeal artery, save that the former occurs more slowly.

Injuries to the middle meningeal artery naturally occur in the immediate neighborhood of this vessel, which is not infrequently ruptured by contre-coup. The artery runs sometimes in a groove of the bone, sometimes in the dura, and sometimes entirely in the bone. The more it lies within the bone, the more likely it is to be ruptured when this part of the skull is fissured. Basal fractures often follow the groove for this artery. The anterior branch is more often injured than the posterior. Extravasations from this source are more common than from all others combined, the amount of blood varying within wide limits. Two hundred and forty grammes of blood-clot have been known to collect, and the dura to be separated down to the very base of the skull. I have repeatedly taken away at least a small teacupful of blood-clot in such cases.

The SYMPTOMS of this hemorrhage are, of course, those of compression, while extravasation may be rapid and quickly fatal, delayed for some time, or may take place in two stages, the first but slight and producing no coma. New clots are always dark and disk-shaped, thick in the middle, with a definite margin. As the clots become older they become more adherent and difficult to remove. The symptoms of meningeal hemorrhage consist of an interval of consciousness or lucidity after injury, followed by epileptic or spastic symptoms, alterations in the pupils and pulse, unconsciousness passing into coma, and stertorous respiration. There may or may not be external evidence of head injury. The character of the *paralysis* (hemiplegia) may indicate that the clot is really upon the side opposite to that of the skull which shows evidence of injury. In this case arterial laceration is the result of *contrecoup*. According to the rapidity of the symptoms is the extent of the primary lesion. Meningeal hemorrhages involve immediately the motor area, which makes diagnosis all the easier.

TREATMENT.—The majority of these cases are fatal when left alone. Hence the treatment is essentially operative, and should be prompt. Of 257 cases collected by Wiesman, 147 were treated expectantly, and of these 131 died; while of 110 cases operated on, only 30 died; and this mortality-rate could be greatly improved upon in favorable cases. Nothing could speak more eloquently for operation than such statistics. The skull should be opened in the indicated area, clot removed, bleeding vessels sought for, counter-opening made in cases where the clot is very large, and drainage established through and through.

One of the earliest and most instructive cases on record as corroborating bold measures in these cases was that reported by Parker, who in the absence of external indication, inferring that he had to do with meningeal hemorrhage, trephined first on one side, and, finding no clot, trephined again upon the other side: here, finding nothing between the dura and the bone, he incised the dura, removed a large extravasation, and saw his patient completely restored to health. This was so late as 1877, at which time it was regarded as an exceedingly bold procedure; which will show what rapid advances have been made in cerebral surgery. It is more important to remove the clot than to find the artery. Consequently, the trephine should be applied at the point most indicated by a study of paralysis. In other words, the principles of cerebral localization should guide, rather than those of arterial anatomy.

Injuries to the carotid within the cranium are exceedingly rare. Still, it has been injured in basal fractures and penetrating wounds.

Development of **arterio-venous aneurisms** after basal injuries is occasionally noted. They will give rise occasionally to pulsating exophthalmos. Pulsating tumors within the orbit which push the eye forward not infrequently occur after serious head injury. Of 77 cases collected by Rivington, 41 had a traumatic origin.

Subdural hemorrhages are not infrequent in the skulls of the new-born, and constitute the so-called *apoplexia neonatorum*. They may occasion convulsions and paralyses of irregular type, while if the extravasations become infected multiple abscess may result.

In adults subdural hemorrhages are, for the most part, connected with those brain lesions which have been already spoken of as contusions. They may be the starting-points for pachymeningitis. Their most common results are disturbances of consciousness and mentality. Paralytic dementia follows in some of these cases. Extensive subdural hemorrhage may give a clinical picture corresponding to extradural. Disseminated minute ecchymoses constitute minute focal lesions, which are, however, usually so distributed as to confuse and prevent accurate diagnosis. Apoplexy or intraventricular hemorrhages, especially from the lenticulo-striate artery (Charcot's "artery of hemorrhage"), have until very recently never been regarded as warranting surgical interference. Of late, however, especially in the ingravescent or progressive forms, ligature of the common carotid has been of some service, though in order to render this effective ligature must be made very early in the course of the case.

Traumatic intraventricular hemorrhage occurs in much the same way as meningeal, by contre-coup. Individuality of symptoms is lost in the general comatose condition of the patient, but when operation is performed, as it is usually best to perform it, if no extradural clot be found and if brain-tension be evidently increased, the dura should be opened; after which, if no subdural clot be seen, the ventricles should always be tapped with the exploring needle. In this case, if blood be removed by aspiration, a knife should be passed directly into the ventricle, after which blood will promptly escape, if present. Dennis was the first to diagnose the presence of intraventricular clot and to deliberately incise into it, and I have myself repeatedly imitated this procedure, both with and without success.

LACERATIONS AND INJURIES TO THE BRAIN-SUBSTANCE.

These have been already nearly sufficiently alluded to under the term *contusion of the brain.* They may be divided into those which occur with or without fracture of the cranial bones. The term contusion was first suggested by Dupuytren. The condition comprises all degrees of injury, from the most minute local disturbances to lesions involving the entire hemisphere. The milder forms show a sprinkling of punctate hemorrhages, numerous in the centre of the injured area, the surrounding tissue taking on a more or less diffused tint, which fades out toward the periphery, discoloration being due to the imbibition of the coloring matter of the blood. In more extensive injuries clots as large as peas or larger are imbedded at various points, each surrounded by its area of discoloration. When foreign bodies have been driven into the brain, the tissue is also discolored, while various foreign materials may be met with. In an instance of great violence there may occur absolute rupture of brain-tissue extending from cortex to ventricle.

When the body which causes the injury is small the contusion will be found usually close to the site of injury or perhaps opposite to it (contre-coup). The cerebro-spinal fluid is an important agent in the production of disseminated and even distant lesions. When the lateral ventricles are compressed their contained fluid seeks to escape through the Sylvian aqueduct into the fourth ventricle and the central canal of the cord, all of whose walls may be materially injured by this sudden distention. In these locations especially, then, we expect to meet with minute extravasations. They have been seen even as far as the lumbar portions of the cord. The combination of contusion and intrameningeal hemorrhage is most common, and is that portrayed in Plate II. It is the feature of contusion which constitutes the most serious complication and the most serious obstacle to recovery after operation for removal of sub- or extradural clot.

PROGNOSIS.—Prognosis depends in large degree upon escape from or occurrence of infection. In infective cases the principal dangers are from blood-pressure and from later œdema or acute softening. Brain lacerations may heal by cicatricial repair, but usually with some perversion, at least trifling, of function.

The possibility of *cystic degeneration of large or small clots* is one of very great importance. (See Cystic Softening, p. 392, Volume I.) A blood-clot now within the cranium which fails to resorb is essentially a hæmatoma, in whose interior softening and conversion into a cyst may easily occur. These cysts make room for themselves at the expense of surrounding brain-tissue, and when located in the motor area give rise to localizing symptoms as well as to epileptic convulsions. They may be often diagnosed with certainty after an accurate history of the case and the study of the phenomena which it presents. As they grow older their walls become firmer, and it is often possible to dissect them out as one removes any other cyst from its surroundings.

That *foreign bodies may be encapsulated* and remain without producing disturbance is now well known. As a rule, however, though encapsulated, they produce symptoms like headache, vertigo, etc.

FIG. 13.
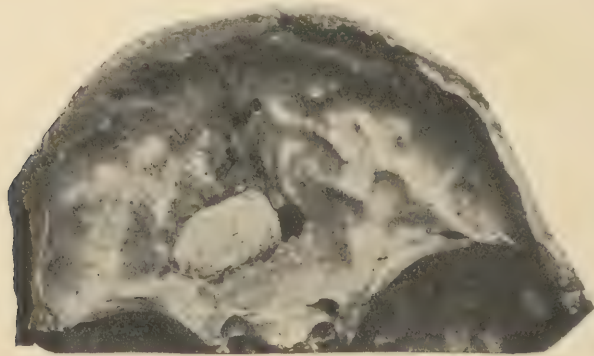
Bullet imbedded in anterior fossa (U. S. Army Med. Museum).

In *penetrating wounds* the canal usually terminates in a blind extremity, although points of knife-blades or other foreign bodies may remain in its depths. It is important to remember that the brain may be penetrated through the orbit or the nose, and that small substances introduced in this way may cause subsequent fatal meningitis. Thus, fragments of glass, umbrella tips, ends of foils, knife-blades, etc. have produced cases whose history is interesting reading, but which cannot be detailed here. Needles have been found in the brain which must have been introduced long before, probably in infancy, and which appear to have caused little or no disturbance.

SYMPTOMS.—The general features of brain lacerations are those of

contusion already alluded to, somewhat exaggerated in many cases. So long as the disturbances are minute, even if multiple, or the foreign body small, compression symptoms are not produced, or at least in very incomplete degree. Minute diagnosis is, of course, impossible. The most essential thing is to decide upon the question of operative interference. In the absence of distinctly localizing symptoms or other external markings, which of themselves would indicate operation, it is usually abstained from. Upon the other hand, a lesion which can be distinctly localized is probably due to extravasation large enough to be quite probably reached by opening the skull ; and, unless there be other and sufficient reason to the contrary, this should be done.

In many instances, however, contractures or paralyses of muscle-groups occur later, and are followed by spastic conditions which may be permanent. More can be done in these cases by massage, by internal medication, perhaps with external counter-irritation, than by distinctly surgical procedures. Both albuminuria and glycosuria are known to be the result of injuries herein referred to, as well as bulbar paralysis and disturbances of special senses. More immediate dangers after these head injuries are those of broncho-pneumonia or hemorrhagic or œdematous infiltration of the lower lobes of the lungs—conditions often spoken of as *hypostatic pneumonia*, much resembling those produced experimentally in bilateral division of the pneumogastrics. Some of them are produced by paralysis of the glottis, the result of which is incomplete closure, with aspiration of fluids and solids from the mouth whose decomposition sets up an infection within the lungs which is often spoken of as *aspiration pneumonia*. Some form of pulmonary disturbance follows in perhaps one-third of the cases of the injuries above alluded to, and should be guarded against in every possible way.

TREATMENT.—Most important of all is it to emphasize that the safety of these patients depends in large measure upon the treatment *primarily received at the hands of the first medical attendant*. If this be careful and aseptic, complications may be avoided ; if otherwise, infection within the cranium or within the thorax is very likely to cause the patient's death. *Absolute and primary disinfection of all external injuries*, no matter what may be considered the condition within the cranium, and rigid care with regard to the feeding of the patient and his general nursing, will never be more life-saving than in these instances. These remarks are made because contusions and the more extensive lacerations are rarely met with in the absence of some scalp wounds or fracture, which of themselves should be treated along lines already clearly indicated. When the trephine is not called for on account of external injury, its use should be dictated entirely by what may be judged of the internal conditions and by indications already considered.

PROLAPSUS AND HERNIA CEREBRI.

Escape of brain-matter beyond its normal level is not uncommon in connection with compound fractures or their sequelæ. It may be primary, escaping with the blood at the time of the accident, or secondary, occurring during the ensuing days. Any lesion of this kind in which the brain appears or can be handled is entitled to the term *prolapsus*, in

contradistinction to *hernia*, which implies that, though escaping from the proper cavity, it is nevertheless covered by other textures—*c. g.* dura or scalp.

The protrusion may vary in size from a very small tumor to one the size of a fist. It is always the result of increased intracranial tension, and may be produced by hemorrhage, by serous imbibition, or as the result of brain-abscess. When immediate, it is of the first variety; when later, of the second or third. When abscess is present it usually delays a protrusion, which is produced by degrees. Prolapse occurs for the most part through large openings, such as those made by gunshot wounds, the trephine, etc. Prolapse proper implies laceration of the dura. It pertains obviously to the convexity of the skull, occurring, however, in exceedingly rare cases into the orbit, etc.

The PROGNOSIS is generally unfavorable. There is always risk of œdema or infection, either of which may prove fatal.

Infiltration, gangrene, suppuration, or repair by granulation may so disfigure and disguise the real brain-substance as to lead to *error of diagnosis*. It by no means follows that every tumor presenting through an opening in the skull is of this character. When gangrene and spontaneous separation occur, spontaneous recovery may follow, the stump being covered by granulations and finally roofed over by connective tissue.

TREATMENT.—Treatment in the primary cases should include the most rigid asepsis with removal of all foreign particles. Localized pressure does some good, especially in those cases where it can be tolerated. Signs of abscess should always be watched for, and deep exploration is often justified or indicated. While excision, cauterization, etc. are often heralded as successful, they are by no means without their dangers. Cases that admit of it should wear a protective shield properly moulded to the part. Skin-transplantation, or even osteoplastic repair of the defect, may give good results in favorable cases.

INJURIES TO CRANIAL NERVES WITH OR WITHOUT LESIONS OF THE CRANIUM.

The *olfactory nerve* is sometimes injured by penetrating wounds of the frontal region, or, again, by infiltration of fluid along its course through the pores of the lamina cribrosa. In some of these latter cases function returns after a while. Loss of smell is not necessarily due to injury to this nerve, but may be produced by the plugging of the nostril with blood, etc.

The *optic nerve* may be injured at any point. It has been torn from the globe by external violence; foreign bodies may be imbedded in it, etc. When the lesions occur posterior to the entrance of the central vessels, the ophthalmoscopic picture will be normal, at least for some time, but when anterior to the vessel entrance changes are produced much resembling those of embolism of the central artery. The optic canal is often injured in basal fractures and the optic sheath more or less filled with blood, whose presence is not always easily accounted for. Fragments may be splintered from the canal, and these may injure the nerve.

The *oculomotor* or *third nerve* may be injured during birth by the pressure of obstetric forceps, as well as by fractures of the orbital roof or by penetrating wounds. Paralysis of the *fourth nerve* after head injury is very rare. The abducens is paralyzed in some cases of pulsating exophthalmos.

Injuries to the *fifth nerve* are mostly observed in connection with extensive lesions involving as well the other cranial nerves. Anæsthesia of the trigeminal area after head injuries leads to a neuro-paralytic lesion of the eye, and there is reason to think that many cases of unilateral atrophy of the face are due to some injury in the neighborhood of the petro-basilar synchondrosis.

The *seventh* and *eighth pairs* are more frequently injured—the facial, for instance, by the obstetric forceps during parturition at its exit from the skull, or by various blows from the outside. In basal fractures it alone, or with the auditory nerve, has been paralyzed in numerous instances. When the facial is torn across, as may easily happen during its passage through the petrous bone, paralysis may be immediate, and probably permanent. If improvement or recovery follow, the nerve certainly has not been divided, but the paralysis is probably due to pressure by blood-clot in the Fallopian canal. In other instances where facial paralysis comes on more slowly it is probably due to an ascending neuritis.

Disturbances of the *auditory nerve* have more significance in diagnosis of basal fracture than those of the facial. Hemorrhages into the internal ear, or even filling of the middle ear, may occur without fracture, but the presumption is in favor of such injury.

The other cranial nerves have been known to be injured in one way and another, but such injuries are mere surgical curiosities, save in those cases where the lesion is so extensive as to determine a speedy death.

Septic Infections within the Cranium.

Under the general term **septic infection** I mean to include—

A. Abscess ;
B. Thrombosis ;
C. Sinus phlebitis ;
D. Meningitis ;
E. Encephalitis ;

these being in effect different manifestations of infection, the clinical picture differing according to the tissues and localities involved. For the production of these infectious conditions no special bacteria other than those already alluded to in Chapter III. Vol. I. are comprehended. Their method of activity is there discussed at sufficient length, and we need here only consider the various **paths of infection**. These may lie along the *blood-vessels*, the *lymph-vessels*, *nerve-sheaths*, and prolongations of the *membranous sacs* which extend from the cranial cavity proper.

There is free communication around the brain-box of all the sinuses or cavities which contain air which have to do with the senses of smell and hearing. There is, furthermore, free communication between the orbit and the interior of the cranium. Infection commencing in the nose may spread to the ear by the Eustachian tube, to the frontal and ethmoid sinuses by means of the continuous lining membrane, or to the brain proper or its membranes by the lymphatics, whose connection therewith has received ample demonstration. When the middle ear is filled up with granulation-tissue, this will form a most favorable site for the development of micro-organisms. The same is true of the frontal sinus when the infundibulum is partially closed. In both of these cavities, as in the mastoid cells, organisms find a closed incubating chamber most favorably located. The extension of both the subdural and subarachnoid spaces along the optic nerve will easily explain the transmission of infection from the orbit to the brain. It has only been recently recognized that the teeth also constitute paths of infection, and abscess in the brain may be found containing pathogenic organisms normal only in the human mouth. Furthermore, cellulitis in its various expressions may find an easy propagation from the scalp to the membranes, or even to the brain itself.

If the inflammatory process be slow, we may have localized involvement of the dura with extradural abscess, with perhaps adhesive inflammation, resulting in adhesions with the arachnoid and pia; by virtue of which a general meningitis is guarded against. Adhesions failing or when the infection is widespread, we have invasion of the whole subdural space and general leptomeningitis. Both this, as well as abscess, may result from thrombotic or embolic processes alone, which are then secondary to some similar disturbance elsewhere primary.

There are also numerous traumatic conditions predisposing to infection, particularly *punctured wounds*. Here infective thrombosis in the diploë extends along the perivascular sheaths to the brain. In subperiosteal abscess deep extension is also favored. Punctured fractures, as basal fractures, permit the introduction of infective materal. Even from contusions and injuries which have not produced fractures we may get external abscess, which may later communicate an infection to the interior.

The most common of all the paths of infection is afforded by the *middle ear*, especially when involved in a chronic suppurative lesion, which is by no means necessarily connected with the patulous tympanic membrane, and which may consequently be undiscovered, though in more or less constant activity.

A. Abscess of the Brain.—This may be *traumatic* or *non-traumatic*. The former variety is for the most part due to the direct result of injury, infection displaying its consequences promptly or sometimes not until long periods of time have elapsed. The ordinary form occurs within the first two weeks, usually as an acute cortical abscess beneath a more or less compromised membrane, surrounded by a zone of red softening, and this by another of brain œdema. The *chronic* traumatic abscesses are less often cortical, but usually are deeper. They are usually marked by prolonged suppuration of the external wound, but sometimes occur through some mechanism not yet well understood. Only the chronic abscesses show *encapsulation*, the capsule partaking of the character of the pyophylactic membrane (see Vol. I. Chapter IX.) elsewhere described. It may cover a long period of time—to my personal knowledge at least nine years, while others have mentioned twenty and more. The *non-traumatic abscesses* are for the most part due to *middle-ear disease*. When the roof of the tympanum breaks down, it is the middle fossa of the skull which is infected; when the posterior wall, naturally the posterior fossa. The most common results of perforation of the tympanic roof is involvement of the mastoid antrum or the sigmoid groove and sinus. In the former case we get temporo-sphenoidal abscess; in the latter, cerebellar, if any. Previous to actual perforation there is thinning of bone with thrombosis along the minute veins connected with the sinuses. When the dura is exposed by the carious process, granulation-tissue often protects it against further inroads, while masses of the same projecting into the tympanum have been mistaken for prolapse. If the sigmoid groove be the site of the first disturbance, extradural abscess may form between the sinus and the remaining bone, the granulating process then involving the whole bony groove. Its later consequence is *sinus phlebitis, sinus thrombosis,* or *intradural infection*. If there be adhesion between the dura and the cortex, we get actual brain ulceration without formation of a true abscess; but if once the perivascular sheaths have carried infection to the substance of the brain, there is a rapid purulent disintegration of the same, and formation of a true subpial or deep abscess, which latter is in effect a purulent en-

cephalitis. Macewen has shown how important it is not merely to evacuate such abscesses, but to eradicate the path of infection from the point of origin, which is rarely easy.

Extradural pus may escape into the mastoid cells by erosion of their inner walls. Such pus may escape suddenly, and serious symptoms thus be mitigated. Even abscess of the bone may thus empty itself by the process of adhesion and pointing toward the surface, but such a thing is most rare. Pus from the mastoid cells may perforate the temporo-maxillary joint or escape along the digastric groove and form deep cervical abscesses.

Once the arachnoidal tissue be involved, both subdural and sub-arachnoidal spaces participate in the infection, and the brain floats upon a pus-bed rather than a water-bed. *Leptomeningitis* under these circumstances becomes quickly diffused and fatal. Serous fluid may accumulate so quickly as to produce death by mere obstruction to the cerebral blood-vessels, while distention of the ventricles and an acute infectious internal hydrocephalus is possible. Leptomeningitis may be propagated wherever anatomical paths may carry it, even to the cauda equina and along the spinal nerve-sheaths.

The pus within cerebral abscesses is often discolored, sometimes offensive. A greenish color is usually imparted by the bacillus pyocyaneus, while the offensive odor comes mostly from the bacillus coli. Around every such abscess is a zone of actively inflamed cerebral tissue. If within this zone a pyophylactic membrane may be produced by condensation, the abscess may become encapsulated and life be prolonged. When a capsule fails to form, the process being too acute or rapid, death is the speedy termination of such a case. These abscesses are for the most part single, but may be multiple. There is also a metastatic expression of abscess-formation, seen in typical cases of pyæmia where numerous miliary abscesses are found within the brain. Pressure-symptoms are less likely from abscess than from a tumor of the same bulk, while there is much greater liability to œdema and sudden infection. Gradually extending paralysis implies pathological activity around the abscess. Large collections of pus are often met with in the least vital parts of the brain, as in the frontal or temporo-sphenoidal lobes.

SYMPTOMS OF BRAIN-ABSCESS.—Aside from causal indications (*e. g.* injury to the head, middle-ear disease, recent operations upon the air-containing cavities, etc.), the first symptoms may be slight. They consist usually of headache, often ascribed to cold or trifling injury, becoming exaggerated, rarely definitely located, radiating widely. In time it is spoken of as "excruciating," and may be continuous or intermittent. Vomiting is not infrequent, rarely accompanied by nausea. Chills come on early in the history of the case, varying in intensity, duration, and frequency. The more frequent, the more likely is it that the abscess results from some general infection. Temperature is seldom much elevated ; it is often subnormal. When exalted, it is in proportion to the degree of meningeal involvement. If pressure-symptoms become marked, we get the usual slow pulse due to increased tension. After evacuation of pus pressure-symptoms may subside, but temperature rise. Such discharge from the middle ear as may have been previously noted usually dimin-

ishes. A history of cessation of discharge and of increased pain and fever occurring at irregular intervals is very characteristic.

These patients seldom come under the surgeon's notice until the condition is evidently most serious. If they are still conscious, pain is the dominating complaint. This may be aggravated by percussion over the affected region. Rigidity of the sterno-mastoid on the affected side is a sign of lesion of the sigmoid sinus. Pain elicited by deep pressure in the posterior cervical triangle is also significant. There is mental hebetude, progressive failure of mental and physical power as the stupor increases, or coma becomes marked.

Abscess may be often distinguished from *infectious thrombosis*, since in the latter respirations are quickened and vomiting occurs when the patient is in the upright position.

Vomiting accompanied by cephalalgia is always indicative of intracranial mischief. If it be a special feature throughout the case, it may indicate cerebellar lesion. Convulsions are also frequent, but rarely distinctive. They are the result, for the most part, of secondary irritation of motor areas. Paralysis is the consequence of destructive rather than of irritative lesions.

Much of value can be learned from a careful examination of the ear, and here the careful use of a probe will give much information.

Localizing symptoms are only occasional in connection with cerebral abscess, because the majority of these lesions are located without the motor area. Pupillary alterations are indefinite. As an abscess enlarges the size of the pupil may increase. Infective thrombosis rarely affects the pupils, save that when located in the cavernous sinus it may produce ptosis. In *temporo-sphenoidal abscess* pain is usually localized at or near the ear upon the same side. As the motor area becomes involved we have the gradual development of distinctly localizing phenomena, referred to the opposite side. *Facial paralysis* is common in advanced destructive lesions in the mastoid and tympanum. When produced by cortical lesion it is rarely so pronounced as when by direct paralysis of the nerve. In *frontal abscess* there are few, if any, localizing phenomena. Abscess in the *parietal region* is most commonly of traumatic origin, and is to be suspected in accordance with external surface markings. *Occipital abscess* is exceedingly rare; cerebellar abscess furnishes few localizing symptoms. Its most prominent clinical features are retraction of the head and neck; slow, feeble pulse and respiration; subnormal temperature; violent yawning; rigidity of the masseters; slow speech; optic neuritis; vertigo and vomiting. If accompanied by thrombosis, there is pain and pressure in the upper part of the neck. In all of these cases *when abscess is near the surface there is more or less leptomeningitis*, which becomes diffuse at once when the abscess bursts. If meningitis be present, we have high temperature without marked remissions, rapid pulse, and general irritability, rapidity of pulse indicating predominance of leptomeningitis over encephalitis, since the more marked the latter the slower the pulse. As distinguished from *sinus thrombosis*, we have, in the latter, high temperature with marked remission, rapid and weak pulse, frequent chills, profuse sweats, and often symptoms of pulmonary infarct, or diarrhœa, with cervical and submastoid tenderness and involvement along the jugular vein upon the affected side. *If all three conditions be associated, the symptoms of thrombosis usually prevail*, though we may get retraction of the head due to basilar meningitis. As between tumor and abscess we have in the former absence of explanation of infection, slow progress of symptoms, more definite localizing phenomena, progressive involvement of nerves, pronounced optic neuritis, absence of chill, and alternating periods of mitigation of symptoms. Temperature and pulse afford little help, save that subnormal temperature points rather to abscess.

PROGNOSIS.—From every direction come statements that the tendency of cerebral abscess is invariably toward fatality. No matter what the

cause, unless relief be promptly afforded death is the sure result. Of the acute cases, those not promptly operated usually die within a few weeks; the more chronic or prolonged cases unfortunately rarely come under surgical treatment. Most of those which do are the result of disease in or about the middle ear. Were it possible to diagnose an attack of these abscesses early, prognosis would be much more favorable. When seen before necessarily fatal complications have arisen, in instances where the position can be reasonably well determined, surgical attack is likely to give good results. After proper evacuation even complete mental and bodily recovery is possible. Anchoring of the brain by adhesions may leave a train of disquieting symptoms, which, however, are not so bad as fatality. One must never forget that abscesses may remain for a long time encysted, and yet be a fruitful source of danger. Multiple abscesses may complicate both the diagnosis and the treatment and produce a condition beyond help.

The operative treatment of these cases will be discussed by itself.

B. **Sinus Thrombosis.**—The sinuses are predisposed to thrombosis by virtue of their size, inflexibility, shape, and the fact that they are not emptied during respiration; all of which tend to retard blood-flow. If to these be added defect in the blood-supply, then everything predisposes toward *marasmic thrombosis.* This occurs much less frequently than the infective form, is mostly confined to the longitudinal sinus, is noted mainly at the two extremes of life, and is often seen in cases of death following exhausting diarrhœa in children. In the *marasmic form* the clots are dense, firm, stratified, and non-adherent; they very rarely occupy the whole calibre. In the old cases the clots may be tunnelled sufficiently to permit re-establishment of circulation. Their principal evil consequences are œdema of the frontal lobes and sero-sanguineous effusion into the ventricles or orbits—in the latter case producing exophthalmos. Sometimes epistaxis is produced. Strabismus, tremor, muscle-rigidity or contractures are more often seen conjoined, especially in children, with convulsions, sometimes unilateral, and choked disk.

The DIAGNOSIS in adults is difficult, but in children, when convulsions occur after exhausting illness with the signs just noted, marasmic thrombosis may ordinarily be diagnosticated.

Infective thrombosis, the other variety, is due exclusively to the invasion of pyogenic organisms. It is met with mostly in the basal sinuses; its origin is local, and it is always secondary to some external infection. Its most frequent cause is middle-ear disease; consequently, the sigmoid sinus is the one most often involved. It may follow carbuncle, erysipelas, or cellulitis of the external parts, or nasal ulceration, as well as dental caries, suppuration of the tonsils, etc. Infection may be propagated by tissue-continuity or through the circulation.

Clots form for the most part rapidly, completely occlude and quickly adhere to the sinus-walls; soon they begin to disintegrate, pus is formed, and the resultant fluid is a mixture of blood-elements and pus swarming with bacteria and tending constantly to enlarge the limits of the lesion. The clot frequently extends into the internal jugular, with production of local lesions. Outside, the smooth venous walls have less resistance, and there is more opportunity for dislodgement of clot. Purulent fluid often collects between the sinus and the surrounding bone and may escape by the mastoid vein. Its significance upon the exterior should never be minimized. So, also, it may extend along the posterior condyloid foramen and

produce deep cervical abscess. This pathological activity, if not too rapid, tends to the formation of granulation-tissue around the sinus-walls, which will extend into the bone as into the lumen of a vessel. It may act as a barrier and later organize, or it may itself rapidly break down. The terminal limits of most of these thrombi are protective. Thus, a cord-like mass in the internal jugular, beneath the sterno-mastoid, helps to protect against pulmonary infarct.

SYMPTOMS.—Infective thrombosis presents few distinctive symptoms. Local ischæmia, perversion of function, extracranial œdema are too vague. Headache is nearly always constant, and vomiting is frequent; temperature runs high with marked remissions; the pulse is small and rapid, and remains so even under an anæsthetic. *Chills* are frequent, are of the pyæmic type, and are followed by copious sweats. Should pulmonary infarction occur, we will have the typical thoracic signs, although at first physical examination may give negative results. Later, however, we get prune-juice expectoration, putrid sputum, etc. Cerebral function is disturbed late, rather than early. The duration of the disease ordinarily is from two to four weeks. Should *meningitis* complicate the case, there is more violent headache, persistent high temperature, great excitement, muscle-spasm, strabismus, delirium, and coma; if the sigmoid sinus be involved, there is usually retraction of the head. Should leptomeningitis extend down the spine, girdle pains will be complained of.

We may also have *exophthalmos* on one side or both, with conjunctival injection, œdema of the lids, and disturbances of vision, due to thrombosis of the cavernous sinus and stasis in the ophthalmic vein. In thrombosis of one transverse sinus only the internal jugular on that side will carry less blood. So long as that on the other side is free, it will take that which cannot pass through the obstructed one. Consequently, the jugular on the other side will carry more. But if the contained clot extend so far that direct communication with the internal jugular is interfered with, then the internal jugular of the affected side will be almost empty, while the external of the same side will be the more distended. When the eye is protruded and the frontal vein distended, it is evident that the cavernous sinus on that side is involved. If the superficial veins of the scalp be distended, it is the superior longitudinal sinus which is at fault. When the veins of the mastoid region are involved, we may locate the thrombus in the transverse sinus; when there are no localizing symptoms, we can only say in a general way that thrombosis has occurred.

PROGNOSIS is always unfavorable, though recovery is not impossible. The therapeutics are in the main prophylactic. By actual physiological rest the possibility of pulmonary complications can be diminished. The treatment, aside from this, is purely operative, and will be discussed elsewhere.

C. Sinus Phlebitis.—This may be the result—

(*a*) Of thrombosis; or,

(*b*) The continuation of suppurative processes from neighboring tissues.

Infective thrombi produce sinus phlebitis by direct extension from within, as do surrounding suppurative foci from without. Acute suppurations often follow vessels and nerves, and work their way along the connective tissues surrounding them, and thus penetrate from the dura into the sinus; but for the most part the veins which empty into a sinus are directly responsible for its infection. External lesions as well as internal furnish such infection by means of the wonderfully free venous anastomosis.

In sinus phlebitis the sinus-walls are thickened and infiltrated, while its cavity is filled with breaking-down clot. The veins of the cortex and its membranes are overfilled, and extravasations often complicate these cases. In fact, with sinus phlebitis we often find pachymeningitis and leptomeningitis, and even brain-abscess.

SYMPTOMS.—These are seldom absolutely diagnostic. Sinus phlebitis is often accompanied by meningitis, even encephalitis. The first symptom is usually severe headache, often localized, made worse by pressure. Anorexia, with early mental disturbance and often delirium, follows, with vomiting, restlessness, and mania, changing to stupor and coma. *Rigidity* or spasm of *cervical muscles*, or of those of the extremities, followed by paralyses, is often seen. Evidences of *irritation of special nerves*, particularly the oculo-motor or the vagus, are not rare. When pyæmic symptoms occur they are vague and are most conspicuous in the lungs and liver. Taken in conjunction with aggravating brain-symptoms, they make prognosis most unfavorable.

Symptoms will in large measure depend upon the sinus most involved. They are most characteristic if this be the *cavernous* sinus. Here we have disturbances in the eye on the same side, congestion of orbital veins, pain and photophobia, and, later, cloudiness of the cornea and œdema with exophthalmos. Finally, the pupil becomes paralyzed and dilated, the cornea loses its polish, the upper lid cannot be raised, and, if the case persist long enough, the cornea ulcerates. Along with these local evidences there will be complaint of frontal pain, usually with paralysis of the hypoglossal nerve and consequent thickness of speech. When the *transverse* sinus is involved, we have, first, vagus irritation, then paralysis with paralytic sequences in the muscles of the jaw, the tongue, palate, pharynx, etc. Diaphragmatic motions are interfered with and the character of the respiration altered. As the trouble extends to the internal jugular, we have further paralysis of accompanying nerves, especially of the hypoglossal. As the irritation extends down the vein, we will have tenderness, rigidity, and often swelling. The local signs and symptoms vary obviously as the lesion extends from one sinus to the other, since when one cavernous sinus is involved the trouble nearly always extends to the other, and local symptoms are repeated upon the opposite side.

DIAGNOSIS.—Primary symptoms are those common to all of the intracranial infections. In the presence of pyæmic features symptoms of local involvement, swelling of joints, etc., one can ordinarily eliminate the pure type of meningitis. Should there be evident reason for deep infection, diagnosis is also simplified. Oculo-motor paralysis, ptosis, pupillary alterations, etc., occurring early, are of great importance. Eye-symptoms point primarily to the cavernous sinus, while lesions of the vagus or hypoglossal or glossopharyngeal nerves point to the transverse sinus, as do pain or tenderness over the mastoid or down the neck.

D. **Meningitis.**—The dura has a duplicate anatomical character. Its outer surface, having the structure of periosteum, functionates as such; its inner surface, being lined with endothelium, partakes of the nature of a true serous membrane. When the former texture is mainly at fault, we have pachymeningitis externa, or endocranitis, which is rarely primary, but usually a propagated lesion met with after injury or external infection. It may lead to infiltration with purulent products, and, if speedy exit for pus be not provided, to involvement of the pia within. *Extradural suppuration* without external injury is very rare, but should there have been a subdural hemorrhage with external lesion, the blood-clot may become infected and break down. *Pachymeningitis*

externa is most common after chronic lesions of the cranial bones—*i. e.* caries and necrosis—and is scarcely to be separated from them. *Symptoms* are not characteristic and often not distinguishable. When chronic, there will be local tenderness, evidence of the presence of pus, perhaps with focal symptoms.

The TREATMENT is always surgical, save possibly in certain cases due to syphilis, where delay may be justifiable for the purpose of testing the action of antispecific drugs.

Pachymeningitis interna is often confounded with chronic hydrocephalus. It is frequently the occasion of a firm membranous exudate upon the internal surface of the dura, which forms in time a new membrane rich in small and extremely friable vessels, from which hemorrhages easily occur, thus giving rise to the condition of pachymeningitis hæmorrhagica. Trifling hemorrhages will produce little or no disturbance; when of greater extent they may give rise to localizing brain-symptoms. These extravasations may absorb or undergo fluidification—*i. e.* produce localized or cystic collections of fluid. The condition sometimes occurs after other acute infections, especially pneumonia, pleurisy, typhoid, whooping cough, etc. Recovery is possible, but usually at the expense of adhesions, which lead to subsequent complications.

TREATMENT must be in a large degree surgical, since little short of eradication will bring about the desired result.

The SYMPTOMS *of pachymeningitis hæmorrhagica* are headache, which will increase in intensity with every new escape of blood, usually localized in the vertex, with more or less paralysis following each new extravasation. The final result may be atrophy, even extensive. Absence of disturbance in the cranial nerves points to lesions in the convexity rather than basal or ventricular. In chronic cases we have optic neuritis, and toward the end coma, coming on for the most part slowly. Dennis has recommended trephining under these circumstances, and has practised it with great benefit.

Leptomeningitis.—This term refers to inflammation (*i. e.* infection) of the pia mater, in whose texture we encounter tissue quite different from that composing the dura, and in which, when inflamed, distinction as between arachnoid and pia has disappeared. *Leptomeningitis suppurativa* is an exceedingly common expression of intracranial infection, and may result not merely by extension, but as a primary infection. When begun, it spreads most rapidly, the fluid contained within the meningeal cavities, mixed with pyogenic agents, helping to disseminate the active agents to the ultimate limits of the membranous involvement. Consequently, basilar meningitis usually extends down the spinal canal. Next to injury, the most frequent cause is *middle-ear disease* with its infectious complications and extensions. Next to this come sinus phlebitis and endocranitis. Infection from the teeth and the nasal cavity may occur. It is also known to result from panophthalmitis: in traumatic cases, when primary, it sets in early, even from four to thirty-six hours after injury. So rich is the pia in loose connective tissue that even from the outside the inflammation may assume the phlegmonous type. The cerebro-spinal fluid, as well as that of the ventricles, becomes cloudy, contains numerous flocculi, and is often blood-stained.

SYMPTOMS.—When the disease is limited to the vertex and follows

several days after injury, it begins usually with chills and malaise, with increasing temperature ; after which the symptoms assume the pyæmic type, distinguished from true pyæmia by their comparatively early onset. The pulse becomes frequent, first full, and then small ; patients are disturbed, restless, or uncontrollable, complain of headache, moan, grate the teeth, become delirious, with glistening eyes and congested face. After a while delirium subsides into stupor and restlessness into insensibility. The pupils contract and remain inactive to light. Paralyses, cramps, etc. are not infrequently met with. *Traumatic basilar leptomeningitis* occurs often with fracture of the base. Signs and symptoms are less distinctive here ; paralyses occur more easily and are less distinctive, save those which involve the special cranial nerves. When *ptosis* occurs with dilatation of the pupils, glossopharyngeal paralysis, etc., we should be quick to suspect extension of the process along the brain. Cramp or stiffness of cervical muscles means the same thing, and is a sign of very grave import ; it may even be considered pathognomonic. Albuminuria is frequent, with marked increase of phosphates in the urine.

In the non-traumatic cases the symptoms of leptomeningitis are those of increasing brain-pressure and temperature. The disease usually commences with headache followed by vertigo, hyperæsthesia, restlessness, delirium, insomnia followed by somnolence, muscle-spasm, paralyses, coma, and death. If the disease extend from the middle ear, we frequently have facial paralysis before the meningeal symptoms appear.

The type of fever is one of gradual increase, though before death temperature often falls even below the normal. Pathognomonic fever should not be mistaken for the elevation of temperature which often accompanies absorption of intracranial hemorrhages. In these latter cases temperature may amount to 39° C., but if rising higher than this, meningeal complications should be suspected.

DIAGNOSIS as between sinus phlebitis and leptomeningitis depends for the most part upon the recognition of pyæmic symptoms. When the latter are entirely wanting, we may at least say that the predominating symptoms of sinus phlebitis are absent.

PROGNOSIS is almost always bad. Many cases end in forty-eight hours ; others may live for two weeks or more.

TREATMENT seems almost futile, though one should endeavor by energetic purgation, venesection, etc. to do what he can. The only prospect or hope comes from the possibility of relieving the compression from effusion of purulent fluid, and of irrigating and draining what is now an enlarged abscess-cavity. Since now we do not hesitate to open and wash out other serous cavities when thus affected—*e. g.* peritoneum, pericardium, joints, pleura, etc.—we should no longer hesitate to open the dura and wash out the subdural space, even though this necessitate more than one trephine opening. The measure was suggested by S. W. Gross in 1873, when he reported cases thus treated with success, and has since been practised by other surgeons, among them by Souchon, who has advised multiple puncture with the small drill and irrigation and disinfection through numerous small openings. Of 11 cases collected by Gross more than twenty-five years ago, 45 per cent. recovered.

E. **Encephalitis.**—The etiology of this condition is practically that of leptomeningitis. It may proceed from sinus phlebitis or from the

veins emptying into the sinus, infection travelling backward rather than
forward.   In many cases the primary infection occurs from without, as
in gunshot fractures, etc.   It is also transmitted along the lymphatic
channels, since I have operated on abscess in the frontal lobe following
intranasal operation.   It assumes practically always the suppurative
type, and may run either an acute or a chronic course.   When acute,
the lesion is usually limited in area, and the result is an acute abscess
with irregular boundaries.

Symptoms.—These will depend largely upon the portion of the
brain involved and the acuteness of the process. Symptoms may even
be almost lacking. When present, they are mainly those of brain-
pressure, often with localizing phenomena. Convulsions with loss of
consciousness, vomiting, slowing of the pulse, stertorous breathing,
almost always follow a serious form of diffuse encephalitis. When
pyæmic symptoms complicate the case, they point toward a sinus phle-
bitis as the origin of the encephalitis. These collections of pus within
the brain may long lie latent or encapsulated, and then be suddenly
aroused into acute activity, proving fatal by an acute dissemination with
serous œdema ; all of which will be evidenced by symptoms as given
above.   When active trouble is aroused, it is ushered in by chills, after
which compression symptoms occur very promptly.

DIAGNOSIS must be made largely upon the history.

PROGNOSIS is always unfavorable, and TREATMENT will depend
entirely upon what can be inferred as to the nature and location of the
primary cause. In most cases by the time a diagnosis is fairly arrived
at it is too late to do anything.

OPERATIVE TREATMENT OF INTRACRANIAL SUPPURATIONS.

In dealing with pus the surgeon can never follow a safer rule than to
go according to this dictum : i. e. that pus left alone is a greater source
of danger than the surgeon's knife judiciously used. Consequently,
ubi pus, ibi evacua, applies to intracranial collections as well as others.
For its detection and evacuation, operations are now regarded as not
merely justifiable, but indicated whenever there is presumption of its
presence. Discussion now hinges entirely upon the wisdom of explora-
tion when absolutely no diagnosis can be made. But when we re-
member the inevitably fatal tendency of these abscesses and the rela-
tively exceedingly small danger of exploration, we may feel that there
is at least no part of the cerebral cortex where pus may accumulate
where it may not also be attacked with propriety. Save where an open-
ing already exists, trephining is a necessary preliminary. Among other
indications is spontaneous escape of pus through previous opening or any
of the natural outlets of the cranium, with or without localizing phe-
nomena. Further indications are those pertaining to the bone—i. e. loos-
ening of pericranium ; or to the scalp—i. e. œdema, puffy tumor, etc.;
and certain other indications are those of a more general character, chills,
pyrexia, etc. When the dura is exposed, much can be judged of by
the existing brain tension, it being now well established that brain
pulsation is often characterized by the presence of pus beneath the dura.
The most feasible method for detection of subdural or deep collections

is by the use of the aspirating needle—a method now generally in vogue and everywhere accepted.

In most of the suppurations connected with middle-ear disease will come up the question whether to open the mastoid antrum, the mastoid cells, or the brain-cavity proper. Indications for the first of these are —history of repeated mastoid swellings and tenderness, acute inflammations, with soreness or retention of pus in the region of the mastoid, purulent otorrhœa, with beginning symptoms of intracranial mischief, or persistent otorrhœa with offensive discharge, which may long exist without mastoid swelling. The mastoid may be attacked through the *suprameatal triangle of Macewen*, formed by the posterior zygomatic root and the upper and posterior segments of the external osseous meatus. After opening it with revolving burr or with the chisel, the surgeon must determine the position of its communication with the middle ear and that of the facial canal, the occurrence of facial twitchings often announcing the proximity of the surgeon's instruments to the facial nerve. The middle ear may be opened by extension of the burring process along the outer wall of the antrum to the junction of its roof. Through this opening the malleus and incus may be removed, and should be if diseased ; the stapes should be left if possible.

Temporo-sphenoidal abscess will often be indicated by the escape of pus through the dura above the roof of the tympanum. It may perhaps be evacuated by enlarging this approach to it, though ordinarily it would be much better to trephine above the ear and remove all the sloughs of brain-tissue. If the mastoid be also involved, the incision for opening the antrum may be extended upward two inches, and the centre pin of the trephine placed three-quarters of an inch above the posterior root of the zygoma. After exposing the dura its appearance should be noted. If it be normal, the course of the pial vessels may be discovered through it. Here, again, the use of the aspirating needle will be most serviceable. Abscess once discovered should be freely opened, diploë removed, and the cavity carefully irrigated. After thorough cleansing, drainage-tubes are of little, if any, use. Gauze packing is by all means the most serviceable. This would necessitate the employment of secondary sutures, or perhaps the leaving of the external wound open from the fundus in order to permit removal of the gauze.

In operating upon the *sinuses* it is best to amply expose the sigmoid sinus, the incision for this purpose extending from the tip of the mastoid to the posterior root of the zygoma. From the posterior extremity of the parieto-mastoid suture a line drawn to the tip of the mastoid overlies the course of the sinus. Opening should be made on the level of the bony meatus. The overlying bone varying much in thickness, the surgeon should proceed with great caution. In the course of operations necessitated by middle-ear disease this sinus is usually exposed, and the antrum has been opened when sufficient reason for the condition is not therein discovered. After exposing the posterior wall of the antrum the bone is opened behind it for half an inch. If in the *sigmoid groove* granulation-tissue or pus be found, the surgeon should again proceed with great caution. He should expose much more of the sinus-wall and remove all diseased bone in the locality. Everything outside of the sinus should also be disinfected before it is opened. After incising it and cleaning out its purulent contents it should be packed with gauze. Hemorrhage is practically always under control by tamponing with gauze.

Should the internal jugular vein be felt filled with thrombus or distended, it should be exposed in the neck below the contained clot, ligated, and either split

open or irrigated through, so that communication is free between it below and the sinus above. When one can foresee that this may be necessary, it is wise to operate upon the vein first.

Operation for relief of purulent meningitis has already been suggested. In the absence of definite indications or of opening, the best point for operation is that at which the meningeal cavity may be properly drained. Opening should be, accordingly, made below the superior curved line of the occiput or just above the superior border of the posterior part of the zygoma. It may also be well to open well down in the cervical region. The arachnoid space must also be opened. Souchon's method of exploration with the ordinary bone-drill, whose point is carefully guarded, and the employment of numerous openings with exploration by the fine aspirating needle, may be put in practice when indicated.

CEPHALOCELE.

The term **cephalocele** is applied to tumor of the endocranium presenting through defects in the cranial bones, of essentially congenital origin, and containing more or less of intracranial contents. It comprises—

A. **Meningocele**; which means a tumor consisting of a membranous protrusion and containing cerebro-spinal fluid; and,

B. **Encephalocele**; referring to tumors which contain also more or less of actual brain-substance.

Such tumors of non-traumatic origin can only be explained by the existence of congenital defects which permit the escape of that which the normal bone retains within normal limits. In most instances the defect is in the middle line, at either one or the other extremity of the skull. In some instances the arches of the atlas, or even of other cervical vertebræ, are lacking. The most common cephaloceles are the occipital, which are known as inferior when below the occipital spine, or

FIG. 14.
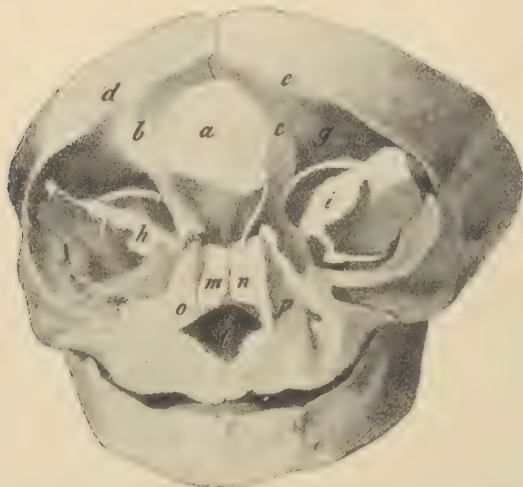
Defect in cranium permitting sincipital cephalocele (Bruns).

superior when above it. Those appearing anteriorly are known as "sincipital," and are met with most often at the root of the nose, where they may communicate with the orbit or the nasal cavity. Other and irregular forms are laterally or unsymmetrically located. Thus, we may have naso-frontal, naso-ethmoidal, etc. Still another group of cephaloceles escape through fissures or defects at the base of the skull, and, sinking between the ethmoid and sphenoid, present in the naso-

pharynx. Thus we may have naso-pharyngeal, spheno-pharyngeal, spheno-orbital and spheno-maxillary cephaloceles. These tumors are for the most part single, and vary in size within wide limits. For the most part they have an even shape and surface, yet are occasionally divided by folds or constrictions. Many of them have a pedicle much smaller than the tumor itself; others are spread bodily upon the skull. The overlying integument may be very thin, reddened, and vascular, even to such an extent that the tumors are mistaken for angeiomata, or it may be so metamorphosed and thickened as to divert suspicion of their actual character, even to imitate lipomata.

Cephaloceles have an elastic feeling, many of them an exquisite fluctuation. Sometimes by touch alone we recognize both their fluid and

FIG. 15.
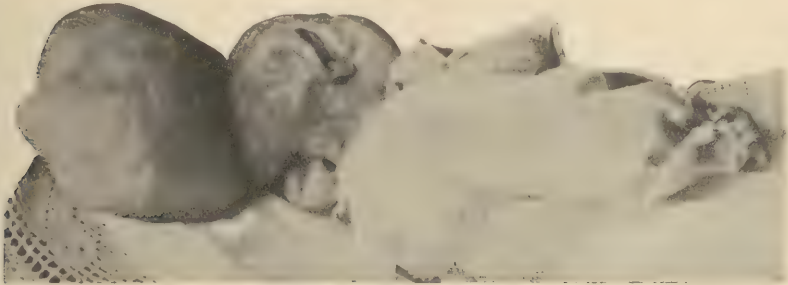
Occipital cephalocele (original).

solid contents. A meningocele with thin walls is *translucent*. By pressure they can be *reduced in size*, such pressure producing usually brain-symptoms, often paralysis or convulsions. Many children thus affected cannot lie upon the tumor without becoming restless. When the little patients cry or make any violent straining efforts, the tumor becomes larger and its covering more vascular, while during quiet sleep it is usually reduced in size or tension.

FIG. 16.

Sincipital meningocele (original).

A large proportion of patients with these congenital defects die shortly after birth. The tumor, when large, may be ruptured during delivery. Occasionally the sac ruptures spontaneously, which accident is usually

followed by purulent meningitis from infection, though it may possibly lead to spontaneous recovery. The principal danger always is of such accident.

The **encephaloceles** are divided into the *cenencephaloceles*, containing solid brain substance, and *hydrencephaloceles*, consisting of the protrusion of a dilated brain-cavity—*i. e.* a thin area of brain enclosing fluid communicating with one of the ventricles. Most of the large tumors pertain to the latter class. The more brain material such a tumor contains the more does it pulsate, especially if the patient cry or strain ; the smaller, too, is the skull—*i. e.* the greater the tendency toward microcephalus.

As between the different forms of cephaloceles, DIAGNOSIS is usually not very difficult. Pure meningoceles are most common in the occipital region ; they are translucent, are easily reduced in size by pressure, and are readily emptied by aseptic puncture. The hydrencephaloceles form large fluctuating tumors, often somewhat translucent, symmetrically developed, for the most part occipital in location, not reducible, and but slightly influenced by full expiration. They are most common in connection with deformed skulls. The cenencephaloceles are probably the only variety which persists to adult life. They are, for the most part, anterior ; may have thick walls ; are only partly reduced in size by puncture ; pulsate with violent exertion ; diminish during sleep ; and are only slightly reducible.

TREATMENT.—Treatment should, first of all, be protective, by a shield of some device held in place by a suitable bandage or dressing. *Compression,* with or without puncture, has given the most generally satisfactory results, but not much should be expected from any method or combination. Most of the cases are such that extirpation would seem applicable, but the impossibility of absolute asepsis in young infants and the liability to fatal shock preclude most of these attempts. In some instances ligature of a meningocele has been successfully applied. In time, injections, as recommended in spina bifida (which see), may also be resorted to. *Operation* may be attempted in young children with sincipital encephalocele. Plastic operations may be resorted to, or plastic manœuvres combined with extirpation. It may be possible by the insertion of a celluloid plate to atone for a small defect in the skull after extirpation of a tumor of this kind. I have successfully practised this method in spina bifida.

HYDROCEPHALUS.

This term is applied to abnormal collections of cerebro-spinal fluid within the cranial cavity. We speak of—

A. **Hydrocephalus ventriculorum** or **internus**, when the fluid is confined to the dilated ventricles of the brain ; or of—

B. **Hydrocephalus meningeus** or **externus**, when the fluid collects between the brain and the dura.

The former condition is much the more common. The cause of hydrocephalus in the young is essentially congenital, and inseparable from imperfect development within the cranium. The forms are occasionally combined. At the time of commencing trouble the skull may

be of natural size, but yields to the accumulation of fluid within, until it attains relatively enormous dimensions. Most children thus affected die early, some shortly after birth. It is most common in rachitic children. Hydrocephalus developing in the adult is the result almost solely of atrophy of the brain. *Pachymeningitis interna* (see pp. 58 and 66) may also produce subdural exudate leading to *hydrocephalus externus.* Encapsulated collections of cerebro-spinal fluid due to pachymeningitis interna are known as *hygromata* of the dura. A *ventricular* form of hydrocephalus may also result from meningitis and tubercular disease. The condition is essentially chronic, the fluid collecting in the dilated lateral ventricles, though the third or fourth are sometimes also distended : 4000 c.c. of cerebro-spinal fluid have been found in more than one instance. As the result of the presence of the fluid there is *atrophy of brain, with arrest of development*, to such an extent even that the hemispheres are changed into great sacs, being merely spread out upon the outer wall of cystic cavities ; all the surface markings are lost, and gray and white substance are scarcely to be differentiated.

For the cranium itself the bones of the vertex separate, and instead of sutures we have a tightly-stretched membrane. There is also congenital or acquired *aplasia—i. e.* absolute defect of bone between dura and pericranium. All these changes give to hydrocephalic heads a distinctive appearance. Other developmental defects—hare-lip, club-foot, etc.—are common in these patients. Many infants thus affected die during delivery unless skilful help be at hand. The resulting disproportion between the enlarged head and the small face is most distinctive. Children in this condition suffer from disturbed digestion, are emaciated, with rachitic curvatures of the long bones ; special senses are seldom developed perfectly ; strabismus and nystagmus are frequent, while cramps, stupor, etc. are by no means infrequent.

Prognosis.—While spontaneous recovery is possible, as already stated, the tendency is always toward fatality.

Treatment.—Operative treatment consists either of *compression* of the enlarging skull by bandages or their equivalent, or the *removal of fluid* by aspiration, with or without permanent drainage. Compression offers very little prospect of success. Moreover, there is always danger of pressure-sores or even gangrene. *Tapping* for hydrocephalus is an old operation long discontinued, but recently revived. The establishment of *permanent drainage* is a recent suggestion. When effusion has been rapid, puncture may be resorted to, but in the most chronic cases drainage seems to be the only promising measure. This, however, is made of extreme hazard by the impracticability, almost the impossibility, of maintaining asepsis, though not *per se* a dangerous operation. In puncturing or draining it is wise to avoid the motor zone and the neighborhood of the principal arteries. Perhaps the most serviceable point at which to trephine, preparatory to puncture or drainage, is about 3 cm. behind the external auditory meatus and the same distance above the base-line of the skull. By directing the puncturing instrument to a point on the opposite side, 6 cm. above the meatus, the lateral ventricle will be entered. (The same direction may be of service in opening an abscess in the temporo-sphenoidal lobe.) While the results of this method have been so far very discouraging, it is, nevertheless, the best

which presents, save in certain instances where we tap the cerebro-spinal canal at its lower extremity. *Lumbar puncture* is a suggestion of Quincke, and is made between the third and fourth lumbar vertebræ, the patient's body being bent forward while it is made. Puncture here may be temporary or permanent drainage may be resorted to. It is a safer procedure than cranial puncture, is applicable both for diagnostic purposes and treatment, and is more likely to give good results.

THE CEREBRAL MEMBRANES.

The purpose of the dura is to serve as an internal periosteum and as a distinct covering for the brain. It has not only a duplicate purpose, but a duplicate anatomical character, its inner surface being lined with endothelium, while its outer surface is densely fibrous. Accordingly, we may have *pachymeningitis externa* and *interna*. The external variety is usually the result of extension of trouble from the overlying bone—*i. e.* from caries and necrosis—as the result of which the membrane thickens and its outer surface becomes covered with granulations, while pus may form between it and the bone, and thus be for a long time shut off from access to parts within. Such collections are known as extradural abscesses. Their symptoms are not characteristic, but will include local tenderness, febrile symptoms, and perhaps focal symptoms. Their treatment is that necessitated by the overlying lesions.

Pachymeningitis interna is often confounded with chronic hydrocephalus externus, to which it may lead. It is characterized by a membranous exudate, at first separable from the dura, to which new layers may be added, which becomes richly vascularized and viable, producing a condition in which hemorrhages, minute or serious, are frequent. When a small hemorrhage occurs between the membrane proper and this adventitious structure, we have a condition often spoken of as hæmatoma of the dura, sometimes giving rise to localizing brain-symptoms. These extravasations may absorb or undergo fluidification or cystic degeneration, producing the so-called hygromata of the dura. These lesions occur for the most part upon the convexity rather than at the base. The condition often occurs after acute disease, and is manifested by headache, vertigo, mild delirium, pupillary alterations, and cramps in the extremities. It occurs in both the young and the old. Recovery is quite possible, but often at the expense of adhesions. *Pachymeningitis hæmorrhagica* is characterized by new formation of connective tissue upon the inner surface of the dura, this new tissue increasing in amount and becoming vascularized from the dura. With lapse of time it may form layers similar to those observed in aneurismal sacs. Hemorrhage from the more recently formed vessels often occurs, and clots an inch or more in thickness may result, which by their bulk cause serious compression symptoms. These lesions occur for the most part over the cortex, and when long existent may result in formation of cysts. The symptoms are vague, consisting mainly of headache, intensified with every new escape of blood, and, later, of paralysis, a study of which may reveal the site of the lesion. Gradual atrophy of one or both hemispheres may result. The pupils are usually contracted and immobile until compression is pronounced, when they dilate. In old cases we have optic neuritis; coma may be the result of fresh bleeding. Dennis has paid special attention to these symptoms, and has urged trephining and exploration for the purpose of revealing the presence of a blood-

clot and practically effecting its removal, if present. He has reported nine cases, some of which amply demonstrate the value of the procedure in cases previously doomed.

Leptomeningitis.—This is often of the suppurative type, and results not merely from extension by continuity, but is often primary, or may be due to the breaking down of gummata, etc. Once existent, it spreads rapidly, the infectious agents having free access to the entire extent of the membrane along which they travel, even down to the end of the spinal cord. Its most frequent cause is disease of the middle ear, the infection spreading along the facial or auditory nerves. It is also often due to a sinus phlebitis and endocranitis—*i. e.* pachymeningitis externa— or it may spread from the nasal cavity. Prognosis is always bad. Many cases terminate in forty-eight hours ; others may extend over two weeks.

The general propriety of *operations upon the cranium for meningeal infections* is now well established, but is too often made a forlorn hope when there is little or no possibility of any help. Could the operation be done earlier, in proper cases it would often be brilliantly successful. It is based upon the same principles which lead one to open other serous membranes when similarly infected. This requires of course the pre-liminary use of the trephine, perhaps at several points, with irrigation of the meningeal cavity, the establishment of drainage, etc. While always an operation of great gravity, it can never be more serious than the condition which may call for it.

Surgical Treatment of Defects of Intracranial Develop-ment.

There are numerous causes which produce imbecility and kindred conditions in the young. Some are in effect congenital, some are post-natal. Within the past few years a number of these cases have been subjected to surgical operation, in many instances with more or less success ; in a few with brilliant results. Mental defect may occur from injuries at the period of birth—mainly hemorrhages, for the most part cortical, though sometimes deep. In either case the clots thus formed frequently undergo cystic alterations. The term *porencephalon* is modern, and applied to changes comprising disappearance of real nerve-tissue with partial substitution by connective tissue, often with other degenerations, the result being atrophic alterations which apparently permit of no remedy. In a case of true porencephalon the outlook for operation is not at all encouraging, nor is it in any cases which are accompanied or caused by a genuine arrest of cerebral development. On the other hand, when the mental condition can be ascribed to the result of injuries, to hemorrhages, to meningeal irritation, to premature ossification, or too early closure of the fontanelles, or when it is accom-panied by evidence of meningeal irritation or any symptoms which point to a definite area of the brain as being the site of the principal disturbance, operation as a *legitimate experiment* may be conscientiously suggested and carried out.

These operations have now been sufficiently tested during the past six or eight years to permit of certain generalizations, which are practically thus epitomized above. Even if epileptiform attacks are diminished in frequency, or mental irri-

tability and continuous crying relieved, if local paresis disappear or optic neuritis seem to subside, if the athetoid condition may be diminished or spastic contractions relieved (all of which things have been accomplished in various cases),—these of themselves will justify the attempt in any case which may seem at all promising. On the other hand, the outlook for imbecile or idiotic children is so unpromising, and the undesirability of prolonging their lives so self-apparent, that even a large percentage of mortality should not prevent the surgeon from offering such prospect as he may by operative measures. If one such child be made self-supporting or redeemed from hopeless imbecility by such operation, it would be no loss, but a relative gain to humanity, should nineteen similarly affected children perish in the attempt to produce this result. This, at least, is my own view of the subject. In accordance with the view, thus expressed, I have operated in nearly twenty cases with a mortality of about 25 per cent. and complete failure to obtain any improvement in about 38 per cent., while in the remainder of the cases more or less improvement, varying from slight to complete restoration to health, has been obtained.

The operation is usually described as craniotomy or craniectomy, and is apt to be successful in many cases of microcephaly combined with idiocy. An *acquired form* will give a better prognosis than will the *congenital condition*. The danger of the operation is often great, and especially so since it is called for in puny, ill-nourished, and badly-cared-for children. To be successful it ought to be *extensive*. It should vary in character and degree—from simple division of the skull along the middle line, from near the root of the nose to the occiput on one or both sides, to the formation of large bone-flaps by cutting away a wide groove of bone so as to relieve pressure upon the hemispheres. The accompanying figures will present the various ways of performing the operation. It

Fig. 17.
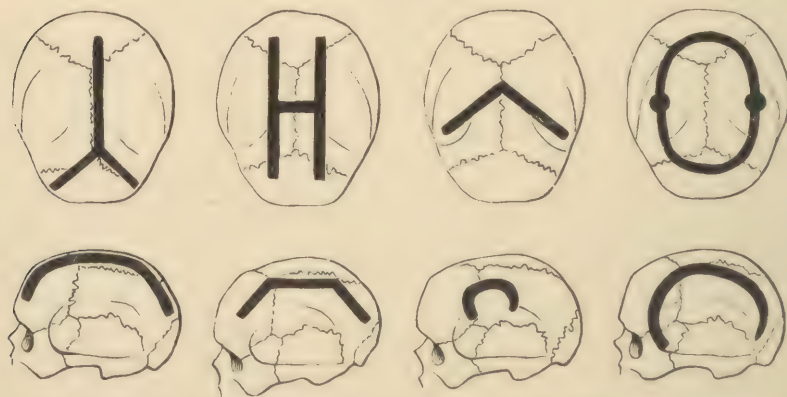
Lines of removal of bone as practised by the author, by Lannelongue, and by others.

can usually be made bloodless, or nearly so, by an elastic tourniquet around the skull. The incision in the skin should not correspond to the groove in the bone, but should overlap it some little distance. For my own part, I prefer to do most of these operations in two sittings. I would advise, as a rule, to prepare the scalp carefully for operation, to divide the skin along the proposed line, separate it from the pericranium and check all oozing, packing the longitudinal wound with gauze and putting on suitable dressings, and waiting a few days or until the child has sufficiently recovered from the shock of the first operation before

doing the second; then, at the second operation, after opening the skull with the trephine, to cut away with proper forceps (rongeur) along the desired line, or, if provided with it, to remove the bone by some surgical engine or revolving saw actuated by electricity. The strip of bone thus removed should be at least half an inch wide, and the overlying periosteum should be removed with it, since only in this way can the undesirably rapid regeneration of bone be prevented. By this means the dura is exposed, but not opened. In many cases this will be enough.

In many others, however, it will be insufficient; and, could this be foreseen, it would be well to combine the above measures in one as a first operation, and then, a week or two later, to take out the gauze packing and open the dura as the second procedure—this, however, only on the discovery by careful inspection that the wound is absolutely free from possibility of infection. Could infection be prevented, this is certainly the safer procedure, since in young children to make a long scalp incision, to remove a long strip of bone, and then to widely open the dura is more than can be safely done in the majority of instances.

It should have been carefully explained to those interested in the case that improvement will in all probability be extremely slow, and that little or nothing is to be expected at first, even if prompt recovery from the operation ensue. Neither would I advise any one to perform the operation unless parents are willing to assume all risks and abide by the results.

Surgical Treatment of Epilepsy and the Psychoses.

Operations for relief of **epilepsy** seem to date back even to the prehistoric era, and were for centuries done as a purely empirical measure; later, to have been practised with more or less plausible reason; then to have fallen into discredit for long periods of time, with occasional revivals of the practice, until within the past ten or fifteen years the operation has been again revived upon its merits and upon the recognition of more or less accurate indications.

Operations of this character are based upon two fundamental facts: the first, the widespread experience that after various operations epileptic patients have been benefited; and, second, that a certain proportion of these cases, especially those of traumatic origin, are characterized by a localized and definite aura and by a systematic and practically invariable order of muscle-involvement, according, it would seem, to some fixed law, and pointing definitely to a certain area of the brain from which apparently the irritation arises and spreads. This form of epileptic seizure is that generally known as the *Jacksonian*, and is that in which operation is most often of real service.

In spasms of the Jacksonian type there is a *certain order of progression* which is scarcely ever violated. Thus, irritation beginning in the leg centre cannot reach the face centre without traversing that of the arm. It is possible also to have sensory equivalents for Jacksonian attacks, as when they commence with peculiar sounds indicating irritation in the centre of hearing, or with optical phenomena, or with disturbances of smell or taste, the former indicating occipital irritation, the latter irritation in the temporo-sphenoidal region.

The surgeon will often be consulted as to the wisdom of operation in the presence of this condition. In brief and in a general way, the following statements may be made : It is necessary, first of all, to establish a traumatic origin, and epilepsy which has preceded a severe head injury can in no sense be ascribed to it. If it can be clearly established that it has followed injury, and if a distinct scar—especially a scar which is adherent—or depression can be discovered, or any area which is always irritable and which seems epileptogenic when irritated ; or if, again, by close study of the case it can be determined that the aura and the initial muscle-symptoms arise always in the same part—as, for instance, a finger, thumb, foot, etc.—and proceed according to a constant programme,—then one may say that operation is not merely justifiable, but advisable. On the other hand, when neither distinct scar nor distinct history of localizing phenomena can be obtained operation should be attempted, if at all, absolutely as an experiment—an experiment which may be followed by good, yet one which gives little if any promise.

Again, in epilepsy of the non-traumatic type, operation may be advised when it assumes the distinctly *Jacksonian* form—*i. e.* when everything points to irritation proceeding from a localized portion of the brain. In the absence of Jacksonian symptoms operation is even more of an experiment than in the traumatic form.

The operation itself is directed to excision of irritable scars, to exposure of the dura at the point of opening, to the detection and suitable treatment of depressed fragments, dural adhesions, tumors, foreign bodies, etc. It is essential in every case that it be represented to those interested that the operation itself removes the *cause*, but *cannot* be, *per se*, expected to *complete the cure*, especially in cases of long standing, and that the final cure must depend in large measure upon the avoidance of subsequent irritation, upon the establishment of perfect habits of diet and excretion, which are often perverted, and perhaps upon the long-continued administration of drugs, of which the bromides are those most constantly given, perhaps with borax. The reader need not be reminded that *old cases are the least favorable*, and that recent cases are the most so for operation, and that the longer the diseased condition has existed the harder it will be to cure by any method.

I believe thoroughly in operating in selected cases. I am equally confident that indiscriminate operation must lead only to disappointment and to occasional disaster. In the presence of long-standing lesions, like bone depressions, cystic degeneration of old clots, etc., the brain may have been so long pressed upon as to have become atrophied.

The whole subject of the modern surgical treatment of epilepsy is inseparable from the topic of prompt and efficient treatment of all head injuries. Were the indications in these always met at the time of the accident, we should have a much smaller proportion of cases of traumatic epilepsy.

Inasmuch as one object of many of these operations is to break up adhesions between the dura and the pia, one is naturally anxious to know the result after such operations as to whether they do not speedily form anew. There is always this theoretical danger, and it is my custom in such cases to insert beneath the dura, at the point where such adhesions have been divided or torn, a piece of deli-

cate gold-foil, duly sterilized, in order that it may separate these surfaces and prevent the recurrence of the old condition. Foil used for this purpose is perfectly harmless, and I have numerous patients in whom it has been used, apparently without producing the slightest disturbance.

Mental and psychic disturbances after head injuries have been long known, and the suggestion to operate upon the skull in cases of so-called **traumatic insanity** is not new. In a general way, it may be said that whenever distinct mania follows a recognized lesion of the vertex of the skull, and fails to subside within a reasonable time and under proper treatment, there are the best of reasons for raising the scalp, trephining, and exploring as to the deeper condition. Patients might be redeemed from asylums who have long been inmates had this measure been practised at the beginning of their mental alienation.

The same measure will give relief in certain cases of **cephalalgia,** or headache, where the pain is always ascribed to a particular region, and especially when there is tenderness over this region. These operations are, of course, *empirical,* yet as the result of altered nutrition and allayed irritation, relief follows in a fair proportion of instances.

INTRACRANIAL TUMORS.

Until within a few years these were regarded as having interest mainly for the pathologist and clinician, but as essentially hopeless so far as surgical help was concerned. Recent discoveries in the field of cerebral localization and recent experience with extensive openings into the cranium have shown, however, that a small proportion of intracranial tumors are of such a character and so located as to make them amenable to surgical relief. These tumors occur with about equal frequency in childhood and adult life. In the order of frequency they stand about as follows : Tubercular gumma, glioma, sarcoma, cysts, carcinoma, and syphilitic gumma, with a small proportion of fibroma, etc.

The *gummata,* either tubercular or syphilitic, are more common than all the other varieties put together. Cystic tumors may be the result of changes in previous blood-clots or may be of independent origin. Parasitic cysts are in this country exceedingly rare. Gumma pertains mostly to adults. Glioma is the most vascular of intracranial tumors, consequently has more of the erectile character, and may vary in size at different times. When there are marked variations of intracranial pressure there may be good reason for diagnosing glioma. The tumors most suitable for treatment are those which are firm, more or less encapsulated, non-vascular, and placed either on the dura, on or beneath the cortex, and in the cerebral hemispheres. *Tubercular tumors* are seldom *encapsulated,* and about them there is usually a zone of infiltration which constitutes a dangerous area. Dermoid cysts may occur inside the cranial cavity, as well as outside. They are naturally of congenital origin, increase very slowly and insidiously, and are seldom productive of symptoms or signs. Tumors arising from the meninges may press upon, and later secondarily involve, the brain beneath, and are in most respects indistinguishable from tumors of the brain proper. These give rise to localizing symptoms when pressing upon the motor and sensory centres. In other cases there will be vague complaint of pain.

Of 100 cases of brain-tumor selected at random, not more than 5 to 7 per cent. are so placed as to justify surgical attack. In as many more at least the tumors are so located as to justify opening the cranium for mere relief of pressure without any notion or endeavor to attack the tumor itself. *Before opening the cranium diagnosis* should be made as

carefully as possible—first, as to *location ;* second, as to whether *cortical* or *subcortical ;* third, as to the *number of tumors present ;* and, fourth, as to their *general character.* Location is determined in the main by study of pain complained of, by watching patients during convulsive seizures, by determining the extent of local or general paralysis, by careful history which shall reveal the method and rate of extension of these symptoms, and by the study of the optic disks, of vision, and by noting the presence or absence of stupor, nausea, coma, slow pulse, or other compression symptoms.

Tumors in the *sensory zone* affect vision and speech, and reveal themselves largely by irritation symptoms. For instance, a patient with verbal deafness and marked hemiplegia probably has tumor involving the left superior or dorso-temporal gyrus, which, as it grows, would involve loss of muscle-sense and anæsthesia on the opposite side of the body. A patient with headache, vomiting, choked disk, stupor, increasing hemianæsthesia, lateral hemianopsia, without spasm or hemiplegia, probably has a tumor in the white substance of the occipital lobe. If hemianopsia alone be present, there is almost always a tumor upon the inner aspect of the occipital lobe on the side opposite to the dark half-fields, which by downward growth may cause cerebellar symptoms.

As to *depth* and *number,* the former may only be made out by studying the nature and location of the signal symptoms, the presence and order of appearance of the same, presence or absence of headache, and local changes in temperature. Tumors occurring in tubercular individuals are probably *multiple.* When different centres or systems are involved we have also probably multiple lesions present.

It has been generally held that the three cardinal symptoms of brain-tumor are *optic neuritis, headache,* and *vomiting;* and, while each of these is significant, and all of them are corroborative, they are not necessarily present nor does their absence exclude possibility of tumor. *Other signs indicating the presence of tumor, it is a mistake to wait for the development of these three.* The most distinctive feature of all intracranial neoplasms is the *progressive character* of such symptoms as are present.

There is but one form of brain-tumor which is amenable to internal treatment—namely, *syphilitic gumma ;* and in case of doubt it may be justifiable to keep the patient actively under the influence of iodides for a reasonable length of time. This, however, need never be prolonged far beyond two months. Should no improvement occur, to wait longer than this will diminish the benefit of surgical operation.

Operation.—Brain-tumors are operated for two purposes : first, for relief of pain and other distressing symptoms in incurable cases ; and, second, for radical cure if it may be achieved. Operation is justifiable in any case where pressure-symptoms become severe, particularly so when pain is localized to a reasonable extent. Choking of the optic disks is not infrequently relieved and threatened disability postponed. The operation when practised consists in, first, the *exposure* of the tumor ; and, second, in its *removal* if possible.

The tumor may be exposed by any of the methods to be dealt with below, the most serviceable probably being the osteoplastic method, by which a bone-flap is raised, along with the overlying scalp, from which it is not detached. The centre

of this flap is supposed to be calculated to overlie the centre of the deep lesion which it is proposed to attack. In many instances it is well to divide the operation into two distinct procedures, the first consisting in removal of the bone and exposure of the dura; the second, a week or two later, comprising the balance of that which is to be done. But comparatively little shock attends removal of the tumor in the second stage of such a divided operation. After exposure of the tumor its cavity is best packed with a gauze tampon after prompt ligation of all bleeding vessels within the field of operation, although it is usually required merely on account of venous oozing, since it is often possible to cut to the depth of an inch in the brain without a single artery spurting except those in the pia. The tampon is of value if allowed to remain for forty-eight hours, as preventing filling of the cavity with clot or excessive bleeding during the vomiting which may follow the administration of the anæsthetic. In various brain operations I have been led to value highly the styptic properties of antipyrine, which I use ordinarily in 5 per cent. solution in sterilized water. I have no hesitation in spraying this upon the brain or in saturating tampons with it, which may be left *in situ* so long as necessary. A number of the old-fashioned small serrefines, properly sterilized, can also be resorted to, if needed, for securing vessels which may not be easily tied. They can be left in place along with the tampon until the third or fourth day, when all may be removed together.

Next to the danger from hemorrhage is that of rapid œdema of the brain, which may result from increased tension in the arteries or through venous stasis, which later produces lymph-stasis, by which fluid collection in the tissues is still further facilitated. Another reason for using tampons is to prevent such relaxation of veins as may predispose to this œdema. In most respects the operations for removal of brain-tumors differ little, if at all, from those whose general principles are elsewhere enunciated in this work. I am greatly in favor of using secondary sutures (*i. e.* those tied with bow-knots), which may be loosened on the second or third day, permitting the raising of the flap, removal of tampon, etc., and I employ them largely after all sorts of operations upon the cranium. It is my custom often to saturate the tampons which lie between wound-edges with an ointment composed of sterilized vaseline to which is added 5 per cent. of naphthalin. If this be placed between the raw surfaces, it prevents such union between them as will produce oozing when they are separated again for removal of the gauze. Or, instead of the gauze used for this purpose, we may employ the green-silk protective introduced by Lister, which should have been previously carefully sterilized by soaking in strong antiseptic solution.

OPERATIONS UPON THE CRANIUM.

Memoranda in Cranial Topography.—The thickness of the skull varies greatly in different individuals or even in the same person. The very young and the aged are not provided with diploë; hence extreme care must be exercised in perforating their skulls. The skull is also thinner over the sinuses and the meningeal grooves. The middle meningeal artery enters through the foramen spinosum and divides into two branches; the anterior, that most often injured, passing across the anterior inferior angle of the parietal bone; the other passing nearly horizontally across the squamous bone. It is most often lacerated at the parietal angle. The frontal sinuses in many individuals are capacious, and by them in the naso-frontal region the tables of the skull are somewhat widely separated.

The *fissure of Rolando* is the anatomical landmark whose position it is most important to determine with reference to a number of modern surgical procedures, since around it cluster most of the motor areas or centres. It commences at the middle line, about 56 per cent. of the distance backward from the glabella (root of the nose) to the inion (occipital protuberance), and, passing downward and forward, makes with the middle line an angle of 67° to 69°. For most purposes it is sufficient to say that it begins half an inch back of a point midway between the glabella and inion. It may be very easily located by *Chiene's method*, which consists in folding a square piece of paper diagonally and folding this again; after which it is three-quarters unfolded, the acute angle then representing 67½°. If this be properly applied to the skull, one edge of its surface can be made to fall directly over the Rolandic fissure. The fissure may also be located by a simple instrument known as the cyrtometer—a gauged metal strip having a sliding arm

upon it, which, when the long strip is placed over the longitudinal sinus (*i. e.* the middle line of the skull), can be made to fall directly over the fissure. While neither of these methods is invariably and minutely exact, either of them is sufficiently accurate for all practical purposes.

The *fissure of Sylvius* may be indicated by a line drawn from a point 3 cm. behind the external angular process to a point 2 cm. below the most prominent part of the parietal eminence. The short and ascending limb of this fissure is of relatively small importance in this connection.

Reid's base-line, so called, is a line drawn from the inferior margin of the orbit backward through the centre of the external auditory meatus. It is a line often alluded to in cranial topography. The colored plate (see Plate III.) will indicate with reliable accuracy the relation of the motor centres to each other and to the principal fissures and convolutions. It pertains merely to the left hemisphere of the brain, in whose third frontal convolution is placed Broca's centre for speech, the corresponding area upon the right side having no exactly corresponding function. The centre for vision, it will be seen, is located in the cuneus, the most basal portions of the hemispheres being the seat of the special senses of taste, smell, and hearing.

Operation.—The word *trephine* is at present used both as a noun and as a verb, the older term *trepan* being now wellnigh discarded. The instrument itself, as at present made, consists of a section of a tube, one of whose extremities is arranged with sharply-cut saw teeth, the whole provided with a grip or handle, which revolves in a plane parallel to that in which the saw teeth cut. The best instrument is that arranged in a slightly conical manner, so that it may less easily burst through the

Fig. 18.

The Powell electric saw cutting a "trap-door" in the skull.

skull and do harm to parts within. The trephine proper is manipulated by the hand. A variety of substitutes have resulted from applications of human ingenuity to the problem of opening the cranial bones. Some of these are actuated by foot or hand power, with reduplicated mechanisms; others by electricity. The more complicated the mechanism the more likely it is to get out of order, and there are but few of these substitutes which give anything like lasting satisfaction (Fig. 18).

PLATE III.

FIG. 1.

Topographical Anatomy of Cortex.   Localization of Functions.   (Ziehen.)

FIG. 2.

Topographical Anatomy of Inner Surface of Right Hemisphere.   Localization of Functions.   (Ziehen.)

In the common parlance of the day the operation of trephining is made to include any method by which an opening is made in the uninjured cranium or by which an opening already existing is enlarged and made to subserve the surgeon's purpose. Aside from the saws already alluded to, there are in common use a variety of cutting bone-forceps, rongeurs of various device, and a variety of chisels, which are meant to be used in connection with the mallet or hammer. In order to use any of the latter instruments to advantage it is often well, and usually essential, to make the first attack with the trephine of reasonable size, say 2 to 3 cm. in diameter, after which forceps, chisel, or saw may be used as one sees fit. Straight saws are also of occasional usefulness, though not often now employed. For my own part, I prefer to use the chisel and mallet relatively seldom, feeling that the series of concussions resulting from blows of the hammer must add in at least an appreciable degree to the shock of the operation. The common trephine is provided with a centre-pin, which can be withdrawn after a shallow groove has been cut. To prevent slipping of the centre-pin I prefer to mark the point to which it is to be applied by cutting a little nick with the point of a chisel.

In the absence of a wound, relieving one of the necessity of making incision, a flap of scalp is deliberately raised before applying the instrument. When the surgeon has his choice this flap is ordinarily of horseshoe shape, and should be made with its convexity pointing toward the

Fig. 19.
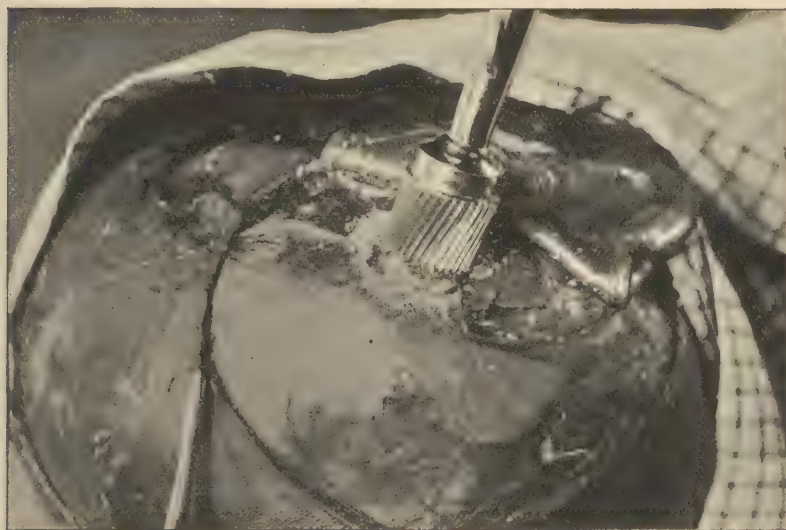
Illustrating the use of the common trephine in depressed compound fracture. A horseshoe flap of scalp has been turned down, and the trephine is applied to firm, unbroken bone in order to make an opening through which the depressed pieces can be attacked and removed.

occiput, since drainage is best afforded later by this arrangement. The old crucial incisions are now wellnigh abandoned. The pericranium is detached, after incision, with the periosteum elevator, and it is always well to turn it up with its overlying scalp without completely separating it. The scalp flap may be best held out of the way by temporarily sewing it to some other part of the scalp, every portion of which should be previously shaved closely and thoroughly scrubbed. The operator has his choice—to seize vessels as they bleed or to make the operation in large degree bloodless by applying an elastic tourniquet tightly around

the scalp above the eyebrows and beneath the occiput, the ears preventing it from sliding. If the tourniquet be used, the vessels will often bleed in an annoying way after the wound is closed. If the operation be performed for fracture of the skull, should there be an opening already made by the depression of fragments it may not be necessary to use the trephine at all, but with suitable bone-forceps fragments may be removed or detached to the necessary amount. In this case, however, there are often sharp points of bone which will require removal by cutting bone-forceps, for the surgeon should leave the margin of the bone-opening comfortably round and smooth. Should there be no opening into which the point of an elevator or of a bone-forceps can be inserted, then one must be made; and it is for this purpose that the trephine is mainly used in cases of fracture of the skull (Fig. 19). It must now be applied upon a firm and undetached surface of bone, one which will bear the pressure necessary in the process of perforation. As used for this purpose, it should be so applied that at least two-thirds of the circle cut by its teeth will be upon unbroken skull; the remaining segment of the circle may be over the fractured area. After it has begun to cut a distinct groove the centre-pin should be withdrawn and the instrument maintained in its position during its work by a firm and steady hand, which shall force it evenly through the bone and not exercise undue pressure upon one side or another. As the diploë is perforated the bone-dust becomes soft and bloody and the resistance is diminished. As the instrument sinks deeper, the operator must frequently intermit its use, and determine his position by means of the irrigator and of the probe or other instrument. The nearer one comes to the inner surface the more caution he must exercise, remembering that the bone is likely to be of unequal thickness. When the skull has been completely perforated at one or two points around the little circle the operator should introduce the point of an elevator and pry up the disk of bone, or by rocking the handle of the trephine he may be able to remove the button with that instrument. When the operation is performed in the ideal manner the dura is scarcely injured, certainly not sawn through by the teeth of the instrument.

In certain of the exploratory operations upon the skull large trephines, having a diameter of 7 to 10 cm., are occasionally employed, but the force required to actuate these instruments is so great as to speedily tire out the hand and arm of any but the most muscular individual. The time consumed is also fully equal to that which would be expended in cutting away the same amount of bone with suitable forceps.

Before opening the dura every loose particle of bone and every splinter should be removed, depressed fragments should be picked out, and those which are semi-detached should be raised at least to their proper level. Through the opening thus made the dura is carefully examined; extradural collections of blood are recognized instantly, while some idea as to the amount of intracranial tension may be secured, even through a small opening. Nothing abnormal being discovered outside of the dura, should brain-tension be great or should the dura be discolored, as by blood beneath, the membrane should be opened, often again by a triangular or horse-shoe flap, and the subdural condition

be accurately estimated. In some cases of meningeal hemorrhage clots will be ejected with no little force the instant the dura be opened. In other cases of intracranial pressure, either from tumor or from intraventricular hemorrhage, the brain will instantly protrude to such an extent as to make its reposition difficult or even impossible.

When there is good reason for its use, one need never hesitate to employ a small aspirating needle in connection with some good suction apparatus. This may be passed to a considerable depth in the brain, when exposed from the vertex of the skull, without producing the slightest recognizable disturbance. By its use it is often possible to obtain most important information. Cystic accumulations, deep hemorrhages, etc. may be determined by this method.

While the scalp incision may be made practically bloodless by employment of the tourniquet, as above mentioned, the blood may continue to ooze from the diploë or from the bone, and hemorrhage from this source be a constant annoyance. It may be checked by crushing the margin of the opening between the points of blunt bone-forceps, by which means the little vessels are compressed; or it may often be controlled, as suggested by Horsley, by forcing into the rough margin of bone some sterilized wax.

Incisions in the dura should be made, so far as possible, parallel with its vessels rather than across them. When accessible, dural vessels can always be secured and tied. Vessels of the pia can also usually be picked up and secured with very fine catgut ligatures. The cortex itself is not so vascular as to afford much trouble. Upon any portion of the membranes or cerebral surface a sterilized solution of antipyrine can be sprayed or applied without hesitation (5 per cent. solution). In all deliberate operations sinuses are avoided so far as possible. When exposed or when necessary to attack them they may be ligated and divided, or may be packed with tampons of sterilized iodoform gauze, or may be seized with serrefines or light hæmostatic forceps, which may be left for a day or two included within the dressings.

Opening the skull, or, in general terms, **trephining,** is at present resorted to for the following purposes:

1. *For relief of compression:*
    a. By depressed bone, as in comminuted or gunshot fracture;
    b. For removal of clot or ligation of vessels;
    c. For evacuation of pus, either from the meningeal cavity or from a deeper abscess;
    d. For the removal of serous effusions, either extra- or intra-ventricular.

2. *For removal of foreign bodies.*

3. *For relief of intracranial irritation*—*e. g.* epilepsy, the psychoses, etc.

4. *For removal of tumors.*

5. *To compensate for defective development.*

6. *For exploratory or purely empirical reasons,* including the making of "relief openings" for relief of pain, etc.

Aside from the ordinary methods of trephining as applied for ordinary conditions, modern surgery comprises the resort to essentially new methods for raising areas of skull of considerable size and then restoring them to their previous position. These are ordinarily spoken of as osteoplastic resections, and have added very materially to the art and resources of the surgeon. These consist, in a general way, of the formation of a window, as it were, in the vertex of the skull by outlining a quadrangular or horse-shoe flap of scalp, which is detached only for a slight distance around the incision, after which, by use of the revolving saw or by chisel and mallet, a groove is cut through the bone running

parallel with the margin of the scalp-flap, but perhaps a centimetre within it. After this bone area is completely cut through on three sides, it is then sprung up or elevated in such a way as to be broken across the base of the bone-flap. It is not at all detached nor separated from the scalp, and so when subsequently lowered into position retains its vitality by virtue of its vascular connections (Fig. 20).

There is scarcely any reasonable limit to the extent to which this method may be resorted to, providing only that the bone be furnished with a sufficient blood-supply from undivided scalp. Consequently, the bone peninsula is made on a lower aspect whenever a large window is thus to be made. Whether this flap shall be immediately secured in position with intimate and primary union, or whether it shall be made to cover a gauze packing for a few days, after which it may be restored to place, must depend on the purposes of the operation and the completeness of its performance in one sitting.

The practice of *replacing buttons* of bone removed during trephining has not found general favor, and is employed by but few, since in ordinary cases the bone defect is replaced in time by fibrous and cicatricial tissue, practically as strong and resistant as the original bone. A much easier and equally effective method is to

Fig. 20.

"Trap-door" operation: bone-flap turned aside, dura exposed. "Osteoplastic resection."

sprinkle over the dura when closed some of the fresh bone saw-dust or some little fragments of bone, which shall be entangled in the clot and which may subsequently serve as centres of ossification.

Where some particular measure seems indicated in order to atone for a large defect in bone, it has become quite customary to insert some *artificial substitute*, mainly either *celluloid* or a thin aluminum plate, previously absolutely sterilized and cut at the time into such shape as may be called for, but a trifle larger than the real defect, being let in or sprung in, as it were, either completely beneath the bone or into the bony opening, so as not to be easily detached or slip out of the way. By this *heteroplastic* method most admirable results have been achieved. I have

used celluloid for this purpose in the spinal column also, closing with it the defect which remained after the extirpation of the sac of a spina bifida.

The question of drainage will always arise. In a non-traumatic case, where every precaution has been observed, drainage will probably only be indicated when we are anxious to provide for the escape of blood or of œdematous effusion. In these instances it can be made with gauze, strands of catgut, or some other capillary drain. In cases of injury to the head much will depend upon the nature of the case and the time which has elapsed between injury and operation. Should time for infection have been given, with probability of its occurrence, it is much better to insert an antiseptic packing, and to close the scalp, if at all, by secondary sutures. In other instances it may be enough to insert a capillary drain or to leave out two or three sutures from the lowest portion of the incision, providing in this way for the escape of material. Halfway measures, however, are most ill advised; and if one be in doubt, it is much better to leave the wound widely open than to close it in such a way as to in the slightest degree contribute toward retention of that which should escape. In brain-abscesses, etc. a rubber drainage-tube or capillary drain wrapped up in green-silk protective will certainly be required.

External dressings should be both profuse and absorbent, and are best held in place by starched bandages. Absolute physiological rest should be insisted upon in the after-treatment, and the excretions should be kept lively, in accordance with the principles enunciated in the earlier portion of Volume I., in order that auto-intoxication in any form may be carefully guarded against.

CHAPTER II.

INJURIES AND SURGICAL DISEASES OF THE SPINE.

By E. H. Bradford, M.D.

Spina Bifida.

Spina bifida is a congenital deformity of the spinal column due to a lack of development of certain of its bony factors. As a result, the laminæ of one or more vertebræ do not unite at the spinous processes and a space is left uncovered by bone. The gap may rarely involve the bodies of the vertebræ, but much more commonly is limited to the posterior portion only. As a result, the lesion is either in or very close to the median line. Through this opening the contents of the spinal canal may, and usually do, project, causing a tumor of variable size,

Fig. 22.

Fig. 21.

Dissected sac in spina bifida (Warren Museum).   Vertebra in spina bifida (Warren Museum).

which may be sessile or may be narrow at the neck, with a true pedicle. Of all the cases, 50 per cent. occur in the lumbar region, 12 per cent. in the lumbo-sacral, and 7 per cent. in the sacral. Spina bifida is, then, the most common in the lumbar and lumbo-sacral regions, more rare in the cervical, almost unknown in the dorsal. The contents of the tumor

may be the cerebro-spinal fluid, the cord itself, or, in the region of the cauda equina, the spinal nerves and nerve-filaments. If the sac contains the lining membranes of the cord and cerebro-spinal fluid, the tumor is called a meningocele; if besides the fluid the tumor contains the cord, it is termed a meningo-myelocele; if the cord within the tumor is dilated with fluid, it is described as a syringo-myelocele. The second of these forms is the most common. The skin covering the tumor may be normal, but is more usually either thickened or thin or translucent. In some instances the skin is absent.

There is usually a direct communication with the fourth ventricle through the pia mater at the lower border of the fourth ventricle. This communication, however, may be obstructed, and in some instances there may be no communication between the sac and the spinal canal. The cord may be situated behind the sac, or it may be spread out on its internal surface, or it may lie in front of the sac. Pressure upon the tumor usually evacuates its fluid contents slowly, but only by increasing the amount of the cerebro-spinal fluid in the spinal and cranial cavity, often with symptoms of intracranial pressure. The amount or character of the contents cannot be positively inferred from the size of the tumor, nor does a large tumor necessarily presuppose a large loss of bony substance in the column. Sometimes the tumor may be so small as to be unnoticed.

These cases seldom cause noticeable symptoms; exceptionally the reverse is true, and serious pressure-symptoms appear where the exciting cause is found to be bands of connective tissue at the level of the spinal opening, exerting compression upon the cord. This variety is called *spina bifida occulta*, and is often characterized by a patch of hair externally. The size of the tumor varies from that of a cherry to that of a cocoa-nut. If the tumor be of considerable size and the cuticle be at all thin, it may increase in size upon physical exertion, such as coughing, vomiting, sneezing, crying. The rapidity with which the tumor may be emptied under pressure indicates roughly the size of the opening in the spinal canal.

The DIAGNOSIS usually offers no difficulty. If a child present a rounded congenital tumor in the lumbar, lumbo-sacral, sacral, or cervical region, in the median line, often varying in size, either with or without a pedicle, and with fluctuating contents, it certainly may be regarded as a spina bifida.

Fig. 23.

Spina bifida in infant.

The COURSE of spina bifida varies. In the majority of instances the tumor ruptures during infancy, the fluid is evacuated, and the patient dies with convulsions or from a septic spinal meningitis. In some instances, however, a spontaneous recovery takes place, and in rare cases

the gap in the bone is closed by a subsequent bony growth. Such spontaneous closure may be observed in a certain number of instances even where it is evident, from paralysis of the lower extremities, that portions of the cord are involved. In another class of cases the life of the child is not directly threatened, but serious symptoms are developed, due to the involvement of cord or nerves. In still another class of cases the condition continues indefinitely without serious symptoms.

TREATMENT.—Treatment may be either *conservative* or *operative*.

Conservative treatment consists of protection of the sac from violence and an effort to prevent the increase of the tumor in size. The tumor should be covered with absorbent cotton and a shield placed over it. The shield may be made of brass, silver, or aluminum, hammered over a plaster cast of the tumor. It may be held in position by a band

FIG. 24.

Case of spina bifida.

which encircles the child's body or by adhesive plaster. Attempts to diminish the size of the tumor by pressure are manifestly irrational, and have been known to result fatally by developing a hydrocephalus, rupturing at the anterior fontanelle. If the skin over the tumor become thin, a layer of cotton is to be placed upon the thinnest portion of the skin and held in place by collodion.

Of *operative measures*, two only are worthy of attention : The first, the *injection of an irritant* within the sac ; the second, *excision of the sac*.

Various methods of injection have been employed, but the following is most to be recommended : The sac is punctured on the side, the trocar being passed obliquely through the healthy skin, and a certain amount of the fluid is drawn off. If the sac is not large, it is better at the first tapping only to draw off a small amount of fluid. From one to two drachms of a solution of iodo-glycerin should then be injected sub-

cutaneously (1 part iodine, 6 parts potassium iodide, and 50 parts glycerin). A moderately fine trocar should be used. After the injection the opening should be closed with dry gauze secured by collodion and iodoform. The surface of the tumor should be rendered scrupulously clean before the puncture is made. The operation may be repeated from four to six times at intervals of a week or ten days.

This method has been especially advocated by Morton of Glasgow: its value was investigated by the London Clinical Society, which collected 82 cases (treated by Morton's method); of these, 35 recovered and 37 died. In 5 there was no improvement, and in 4 there was slight improvement. Morton himself reports 67 cases, with 55 recoveries and 10 deaths. Powers has collected 15 cases, with 4 deaths.

Excision of the Sac.—The treatment of spina bifida by excision of the sac has been successfully done in a number of instances. Various methods of operation have been advocated. An obstacle to a successful operation is met in the difficulty in preventing the copious escape of cerebro-spinal fluid, which by moistening the aseptic dressings becomes a source of infection. The simplest method of *operation* consists in dissecting lateral skin-flaps, opening the sac, returning into the spinal canal any nerve-structures that can be found, closing the divided and dissected emptied sac by means of careful suturing, and uniting the skin-flaps over the whole. Where the opening is large it is not desirable to sacrifice much of the sac, but to fold it into the canal, stitching the opposing external surfaces. If the opening be small, the redundant sac-flaps should be cut off and the cut edges carefully sutured. The treatment of the skin-flaps must necessarily vary according to the size of the opening and the amount of skin.

Osteoplastic methods have been used in the attempt to close the opening by dividing the arches of the vertebra and forcing them together near the median line, securing them by suture. Where the opening is small and the tumor is pedunculated, the sac which contains the dura can be ligated and covered by skin-flap. Attempts have been made to promote the growth of bone by means of transplanted periosteum and by aseptic bone spiculæ. Park of Buffalo has successfully closed the opening by the insertion of a celluloid plate. Hanson has collected 150 cases of spina bifida treated by excision since the introduction of antiseptic surgery: 25 of these were under the care of Swedish surgeons. The mortality from the operation in the whole number was 29 per cent.

Robson thinks excision under aseptic surgery exposes the nerves in the sac to less irritation than the injection of an irritating fluid. He has collected 20 cases of excision of the sac—4 cervical, 16 lumbo-sacral and lumbar. There were 5 deaths—1 on the table, 1 in thirty-six hours, 3 in from three to fourteen days. Of these cases he considers that in 1 the operation was not necessary, and in 2 was not advisable.

There are manifestly three classes of spina bifida :

1. The slight cases, not threatening to burst or enlarge or seriously incommode the patient.

2. The cases beyond surgical reach, where operation is not indicated owing to the condition of the child and the size of the tumor.

3. In those cases where the deformity threatens either life, long disability, or death in time, operative measures are to be seriously considered.

It would seem that in the cases needing operative interference excision is more thorough and surgical than puncture and injection of iodine, providing asepsis can be secured.

It should be borne in mind that the percentage of spontaneous cure has not been accurately determined, and that cases have been observed where spontaneous recovery has taken place after spontaneous rupture of the sac with subsequent gradual narrowing and, in some instances, closing of the bony opening.

SACRAL CYSTS.

Tumors occasionally present themselves in the sacrum, with the characteristics of fatty tumors, lying under the fatty tissue in the region of the buttock. These tumors are usually in the median line, but in some

FIG. 25.
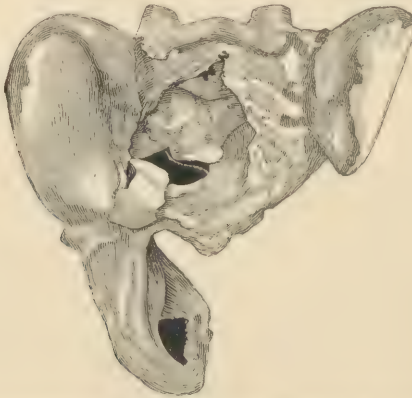
Sacral cyst, showing defect in sacrum (Warren Museum).

instances may lie somewhat to one side. The size of the tumor varies, and in some instances there may be fluctuation, though this is not always the case.

If an incision be made, these tumors will be found to be filled with cerebro-spinal fluid, and if explored an opening will usually be discovered communicating, through another in the sacrum, with the spinal canal. These tumors are, in fact, similar in nature to spina bifida occulta. Operative interference in these cases is a more dangerous procedure than would be imagined, for the reason that it is difficult to secure complete asepsis, owing to the leaking of the cerebro-spinal fluid after operation and the difficulty of securing a proper dressing in that portion of the body in a young child.

SYRINGOMYELIA.

This term is applied to an irregular enlargement of the central canal of the spinal cord, which, beginning as a congenital defect, is increased in later life, with corresponding disturbance in nerve-function, the most noticeable being a blunting of the sensibility to heat and cold, combined with impairment of the motor and tactile sense. The cavity, which may contain fluid, is sometimes so extensive as to encroach on the normal cord-structure, and give rise to loss of integrity of the parts affected by this pressure, with great disturbance in the patient's condition and activity. The affection is one which rarely comes to the attention of the surgeon. Keen mentions 2 cases of his own and 1 of Abbe operated

upon by laminectomy : there was, however, no benefit, and the operation is of doubtful value.

COCCYGEAL DIMPLE AND SINUS.

A small, shallow depression or dimple of the skin is not infrequently seen in the region of the coccyx. This is a vestige of the fœtal opening of the spinal canal.

The closure has been completed in these instances to such an extent that for all practical purposes the opening is entirely covered in, there remaining only a depression in the skin from the incomplete deposit of fat, similar to what is observed over a healed sinus or over the umbilicus. There is in a coccygeal dimple, however, no evidence of scar or break in the skin.

The depression when present varies in different individuals from a scarcely perceptible trace to a cul-de-sac of considerable depth, which may become the seat of inflammation. When the depression is sufficiently deep to form a sac, it may collect sebaceous matter, desquamated epithelium, or foreign substances, dust, cotton or woollen fibre, which, acting as irritants, excite inflammation. If the resulting suppuration do not find free vent, it undermines the skin and an abscess of considerable size may be developed. In certain instances the cavity contains a fold of hair growing from the normal skin which forms the wall of the sac.

There is usually an opening from such a cavity, the coccygeal depression forming a sinus which has been termed a pilo-nidal sinus, as it appears like a nest for the growth of a tuft of hair. Hair, however, is not invariably present. The affection often presents itself as a sinus of considerable size, with ragged granulating edges, in the centre of a mass of brawny skin and situated in the median line or the base of the coccyx. The sinus can be traced through the subcutaneous tissue to the periosteum covering the sacrum and coccyx and into a cavity of undermined tissue.

The TREATMENT is simple. The cavity is to be laid open freely, the inflammatory tissue forming the lining wall is to be thoroughly curetted, and a packing of iodoform gauze inserted to promote healing from the bottom of the cavity.

INJURIES OF THE SPINE.

The injuries to the spine consist of—
1. Fractures ;
2. Dislocations ;
3. Fracture and dislocation combined ;
4. A strain of the spine, with rupture of or injury to the muscles and ligaments ;
5. Injuries to the cord and spinal column.

FRACTURES.

Fractures result either from *direct violence*, a *blow* from a height upon the spine, a *fall*, striking upon an irregular hard surface or projection,

or from the *violent bending* or *twisting* of the spine. As considerable violence is required to produce a fracture of the spine, the lesion is often accompanied by some displacement. If this be considerable, it amounts to a combination of fracture and dislocation. There is frequently also hemorrhage within the canal, and in many instances bruising or crushing of the cord by the displaced fragments.

Fractures of the spine are not common, forming but 3-4 per cent. of all fractures. They are more common in the dorsal and cervical region than in the lumbar, where the vertebræ are stronger. Fractures are more frequent in adult males than in women and children, as the former are more exposed to violence than the latter.

FIG. 26.

The recognition of fracture of the spine is ordinarily not difficult. The resulting disability is necessarily great, and the evidence of a local injury is manifest as a rule. There is frequently also proof of injury to the cord from paralysis of the bladder and rectum or of the limbs.

In some instances, however, where there is but little displacement and the injury is in the anterior portion of the column, the lesion is only recognized by the injury to the nerves or cord, and is manifested by *paralysis of motion or of sensation* and *the condition of the reflexes.*

As Keen has well expressed it, " The spinal cord may be considered as made up of a series of horizontal segments, placed one on top of another like a pile of checkers, and one pair of nerves, right and left, arises from each segment. For example, the fifth cervical segment would be that segment of the spinal cord from which the fifth cervical nerve-roots take their origin." These segments do not agree in position with the numerically corresponding vertebræ. Thorburn has called attention to the fifth-root group of muscles and the position assumed by the patient who has had the fifth cervical nerve crushed. Where this is injured the patient will lie with his arm in a peculiar attitude ; or, in other words, if the fracture be below the fifth cervical nerve there will be abduction and flexion at the elbow, the hand will be supinated, and the humerus externally rotated. If

Fracture of body of vertebra (Warren Museum).

the fifth cervical nerve be involved, the deltoid muscle is paralyzed and the elbow will lie next the body.

At other levels the position will not be so characteristic. The *area of anæsthesia* also varies according to the level of the injury. In general, it may be said that the outer parts of the upper extremities correspond to the upper nerve-roots, the inner portions to the lower. Starr concludes that in the spinal cord the *centres of control of the bladder and rectum are always affected together.* Control over these sphincters is lost when the *lower three sacral segments* are involved. The condition of the reflexes will indicate an injury to the cord at certain

points, and it is possible with careful examination to determine whether there is a total or partial transverse lesion of the cord. *Complete transverse destructive lesions of the cord will give complete muscular paralysis of the parts below the level of the injury, complete anæsthesia below the level of the injured nerve, and therefore complete abolition of the knee-jerk and deep reflexes; but if the*

Fig. 27.

Crushing fracture of vertebral body (Park).

Fig. 28.

Fracture of spine with displacement: section of vertebræ (Warren Museum).

transverse lesions of the cord are partial, the muscular paralysis and anæsthesia will be incomplete. The visceral reflexes, especially those of the bladder and rectum, are affected in the same way.

Differential Diagnosis of Diseases and Injuries of the Spine and Spinal Cord.

	Fracture.	*Dislocation.*	*Hæmatomyelia.*	*Hæmatorrhachis.*	*Acute Poliomyelitis.*
Onset.	Immediate.	Immediate.	Immediate.	Progressive.	Slow.
Anæsthesia.	"	"	"	Incomplete.	Absent.
Paralysis (is of hemiplegic type when compression is unilateral, paraplegic when bilateral, and local when nerve-roots are involved).	Hemi- or paraplegia.	Hemiplegia. In partial dislocation may be absent.	Paraplegia.	Hemi- or paraplegia.	Paraplegia.
Deformity.	Usually present.	Present.	Absent.	Absent.	Absent.
Temperature.	Rises after second or third day.	Same.	Same.	Same.	Precedes the paralysis of degeneration.
Bowels and bladder.	Paralyzed.	Paralysis usual.	Same.	Affected late if at all.	No paralysis.

In the diagnosis of injuries to the spine and its contents it should be remembered that sudden paralysis may be caused by—

1. *Hemorrhage*— { hæmatomyelia,
{ hæmatorrhachis.
2. *Embolism.*
3. *Fracture.*
4. *Dislocation.*

Rapid paralysis may be caused by—
1. *Hyperæmic exudate* in process of repair.
2. *Inflammatory exudate.*
3. *Pus.*
4. *Hemorrhage.*
5. *Acute poliomyelitis.*

The subjoined table, inserted by the kindness of Dr. Dennis, will assist in locating the lesion:

Paralyses and Reflexes due to Spinal Injury.

Spinal Nerve.		Motor Paralysis.	Anæsthesia.	Reflexes.
Cervical.	1.	Death from pressure of odontoid.		
	2–3.	Death from paralysis of diaphragm.		
	4.	Deltoid muscles of upper arm.	Upper shoulder, outer arm.	Pupil.
	5.	Supinators of hand.	Outside of arm and forearm.	Pupil, scapular, supinator, triceps.
	6.	Biceps, triceps, extensors of wrist.	Outer half of hand.	Pupil, scapular, triceps, post. wrist.
	7.	Pronators of wrist, latissimus dorsi.	Inner side of arm and forearm.	Pupil, scapular, post. wrist, ant. wrist, palmar.
	8.	Flexors of wrist, hand, muscles.	Inner side of hand.	Scapular, post. wrist, ant. wrist, palmar.
Dorsal.	1.	Thumb.	Ulnar supply to hand.	Scapular, palmar.
	2–12.	Muscles to back and abdomen.	Skin over back and abdomen in areas corresponding to distribution of spinal nerves.	Epigastric, 4–7; abdominal, 7–11.
Lumbar.	1.	Psoas and sartorius.	Groin.	Cremasteric.
	2.	Quadriceps ext. femoris.	Outside of thigh.	Cremasteric, patellar.
	3.	Abductors and inner rotators of thigh.	Front and inside of thigh.	Cremasteric.
	4.	Adductors of thigh, tibialis anticus.	Inside of leg, ankle, and foot.	Gluteal.
	5.	Outward rotators of thigh, flexors of knee and ankle.	Back of thigh and leg; outside of foot.	Gluteal.
Sacral.	1–2.	Muscles of foot, peronei.	Outside of leg.	Plantar.
	3–5.	Perineal muscles.	Perineum, anus, sacrum, genitals.	Ankle-clonus.

The bladder and rectal centres are in the lower lumbar segments, and traumatism in this region causes incontinence of urine and fæces. Injuries higher up cause retention.

Reflexes are elicited as follows:

Pupillary: Dilatation produced by pinching side of neck.
Scapular: Scratching skin over scapula causes muscles to contract.
Supinator: Tapping tendon at wrist causes flexion of arm.
Triceps: Tapping tendon at elbow causes extension of arm.
Posterior wrist: Tapping tendons causes extension of hand.
Anterior wrist: Tapping tendons causes flexion of wrist.
Palmar: Scratching palm causes flexion of fingers.
Epigastric: Stroking mammæ causes retraction of epigastrium.
Abdominal: Stroking abdomen causes retraction.
Cremasteric: Stroking inner thigh causes retraction of scrotum.
Patellar: Striking patellar tendon causes extension of leg.
Gluteal: Stroking buttock causes dimpling in gluteal fold.
Plantar: Stroking sole of foot causes flexion and retraction of leg.
Ankle-clonus: Forcible extension causes rhythmical flexion.[1]

The PROGNOSIS of fracture of the spine is very grave. Gurlt reports 217 deaths in 270 fractures, but statistics are not of absolute value unless they are still further classified according to the nature of the accident and site of the fracture.

TREATMENT.—The treatment is either *non-operative* or *operative*.

Operative treatment consists of *laminectomy* for the purpose of removing from the cord the pressure of extravasated blood or loose spiculæ of bone.

Chipault advocates early interference if an operation is to be done, owing to the fact that degenerative alterations of the cord take place within twenty-four hours, as has been shown by experiments on animals and autopsies. Lauenstein believes that even if there is incontinence of urine and fæces, with cystitis and bed-sores, an operation is justifiable, as recovery cannot be expected without operation. Horsley is definitely in favor of an operation in all cases where there are symptoms which would show pressure upon the cord. Burrell analyzed 168 cases, and advocates operation in the first twenty-four hours in all cases of fracture, even including those in the cervical region. Thorburn has reported 61 cases of operation, with 35 deaths; Chipault has collected 95 cases, with 38 deaths; Lloyd has found mortality of 57 per cent. after operation.

The danger from an operation increases with the height of the lesion. Where the fracture is limited to the

FIG. 29.

Specimen of consolidated fracture of the spine (Warren Museum).

arches, with displacement, an operation is manifestly indicated. Chipault concluded that in cases of lumbar or sacral fractures surgical interference

[1] From Dennis, by permission.

should be undertaken at once if there be prominence—*i. e.* deformity. If there be a permanent and irreducible displacement of the bony fragments, and the fracture can be reduced by manipulation or is reduced spontaneously, operation should be delayed, but if the case remains stationary, interference is justified toward the end of the first month, but not later.

An operation is not indicated if it is certain that the cord is destroyed. Where it is uncertain, as is usually the case, and where there are symptoms of constant pressure upon the cord from hemorrhage, laminectomy is to be advocated. The procedure, however, is one which in itself involves considerable danger, and should not be undertaken if it be clear that the patient is unable to endure the shock of the operation : this, however, is a question which can only be determined on examination of each case.

A description of the operation of laminectomy is given later.

Non-operative treatment of fracture of the spine consists in placing the trunk and spinal column in such a position as will promote healing. This can be done in an ordinary fracture bed, steadying the patient by sand-bags if necessary. The fixation of the patient's trunk in plaster-of-Paris bandage is of assistance where it is possible. Some surgeons have recommended the suspension of the patient, with or without an anæsthetic ; the procedure is, however, not without danger. The method of application of the plaster corset upon the patient lying in a sheeting hammock, such as is used in caries of the spine, as described elsewhere, has much to recommend it. No anæsthetic is required, and a convenient method for an attempt at rectification of the malposition following injury is afforded.

It should be borne in mind that it is essential that the spine be placed in such a position that the fragments are as nearly as possible in normal relation. Sagging of the bed is to be prevented, and it is sometimes necessary to arch the spine forward (as in Pott's disease) by the use of pads. Traction is sometimes advisable, especially in the cervical region. It may be said that the fixation and placing of the patient are not unlike that necessary in Pott's disease. Especial care is necessary to guard the patient from bed-sores.

DISLOCATION OF THE SPINE.

Ashhurst has collected 394 cases of severe injuries to the spine, of which 124 were pure dislocations, the remainder being dislocations with fractures. It is difficult, however, if not impossible in many instances, to make a certain diagnosis between the two injuries. As a rule, the dislocation is bilateral ; in some instances it is unilateral. *Unilateral dislocation* of the spine in the *cervical region* produces a twist of the neck resembling torticollis. The face is turned to the opposite side, and abnormality in the line and position of the spinous and transverse processes with muscular rigidity is present. If the dislocation be higher, there will be dyspnœa. In some of these instances the torticollis from high cervical caries following an injury is regarded as an old dislocation. The appearance and symptoms are somewhat the same, and there is a noticeable twist, with an alteration in the position of the transverse and spinous processes. A diagnosis can, however, be made by a careful investigation of the history of the case, as the torticollis from disloca-

tion appears immediately after the injury, while that from caries is developed more gradually. In bilateral dislocation the head is thrown back, the chin raised.

Dislocation of the Occipital Bone from the Atlas.—Stimson claims that there are three undoubted cases of this extremely rare accident, which is almost invariably fatal. Extraordinary violence is required to produce this lesion, as this articulation is very strongly protected by ligaments and muscles.

Dislocation of the atlas from the axis is not so uncommon. It is, however, always fatal. The chin is found flexed upon the chest. Death is almost immediate, and comes from the injury to the respiratory centres.

In **dislocation of the lower five cervical vertebræ** the patient's face is usually drawn away from the side of dislocation. There is a prominence on the dislocated side, the muscles being put upon the stretch

Fig. 30.
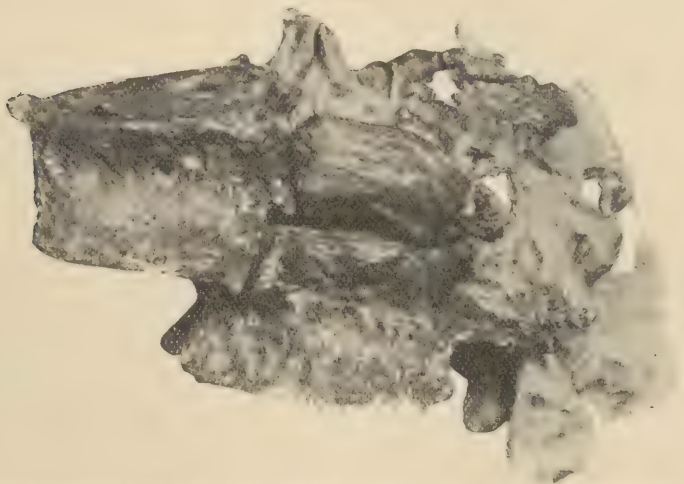
Fracture dislocation with great displacement—patient almost completely recovered (Park).

upon that side; those upon the opposite side are relaxed. There is deviation of the spinous processes. There is frequently deformity inside the pharynx. Dislocation without fracture in the dorsal and lumbar region is extremely rare.

Forcible reduction of dislocation of the spine is necessarily a procedure of gravity. In the cervical region it has been done with success. Great care is needed in the administration of the anæsthetic. An assistant steadies the trunk, while the surgeon, standing at the head of the operating table, holds the patient's head (in cervical dislocation) firmly between his hands, the fingers grasping the back of the neck, the palm pressing upon the lower jaw, and with the thumb reaching under the chin: the necessary amount of traction and manipulation is thus possible. After the correction of the deformity the patient should be placed upon a bed-frame and the head steadied by means of sandbags.

Wounds of the Spine.

The **penetrating wounds** of the spine result either from violence, the use of knives or missiles in war, or from accidents, splinters with penetration of wood, cutting instruments, or falling. They either injure the bone alone or, entering the canal, divide the cord partially or completely. The larger vessels near the column may be injured, causing death by hemorrhage. If the bone alone be injured, the case involves no great danger. The wound should be thoroughly cleansed and recovery can be expected. Where a large artery is divided an exploratory incision is necessary, with control of the hemorrhage by hæmostatic forceps.

In some instances it is impossible to reach the bleeding bone, when pressure by means of packing with antiseptic gauze is all that can be done. In the neck, where the vertebral artery lies close to the column, hemorrhage is to be especially dreaded.

When the wound of the back involves injury to the spinal cord, the symptoms are much more alarming. In some instances, though they are exceptional, the membrane alone is injured. Ordinarily, the cord is either crushed, divided completely across, or partially incised. Cases of injury of the entire cord above the fifth cervical segment are necessarily promptly fatal.

Other cases are recorded of partial incision of the cord which have been followed by almost complete recovery. Where there is injury to the cord there is necessarily paralysis, either complete or partial according to the extent of the injury. It should be remembered that if the division of the cord be unilateral, the paralysis is a cross-paralysis, as has been pointed out by Brown-Séquard and confirmed by 78 carefully recorded cases. The paralysis of motion is on the side of the injury, while on the opposite side there is impairment or loss of sensation.

The TREATMENT of this injury should be governed by ordinary surgical indications, such as cleanliness and drainage. Where vessels are injured the hemorrhage should be checked. In some instances it may be necessary to explore the wounds to see if any foreign body remain in the canal. Thorburn has collected 34 cases, with 21 recoveries—3 complete, 16 with a persistence of some motor or sensory impairment.

Gunshot Wounds of the Spine.—These injuries may vary from the perforation of small portions of the spinal column to the most extensive destruction. The nature of the wound depends somewhat upon the size and range of the missile. There is always considerable shock following the injury, and the lesion is necessarily grave. The lower in the column the wound, the less the mortality; in the cervical region the mortality, according to the *Medical and Surgical History of the Civil War*, is 70 per cent.—63 per cent. in the dorsal and 45 per cent. in the lumbar region.

The SYMPTOMS vary with the extent of the injury and the part injured. Where the missile gives rise to contusion of the spine, there is a temporary disturbance of the function of the cord. Wounds of the muscles or injuries to the ligaments give rise to stiffness of the back. In some instances suppuration and necrosis follow. Where the spinal canal is opened there may be escape of cerebro-spinal fluid, though this symptom is not constant. Where the cord is injured there is partial or

complete paralysis, with resulting anæsthesia and hyperæsthesia. The transverse and spinous processes are more frequently injured than the bodies, but when the latter are wounded the lesion is necessarily more grave.

The TREATMENT consists in cleansing the wound, establishing drainage, and removal of foreign substances and of such spiculæ as can be easily reached. A thorough exploration, with removal of the spinous process, or a laminectomy for the relief of pressure by hemorrhage, would be indicated under certain circumstances where there is a history of paralysis following the injury after an interval of freedom from paralysis.

Park has operated on one case of gunshot wound of the spine and cord, the ball entering the chest, passing through the lung, and lodging in the vertebral column, where, after opening the spinal canal, air entered the chest through the bullet-track, the patient thus *breathing partially through his back.*

Spasm of the Spinal Column.

The spinal column is firmly held by strong ligaments and protected by muscles : it is not, therefore, as liable to receive the slighter injuries as the less protected articulations. In severer injuries, however, it may sustain the same lesions as other articulations, and a sprain of the spine will give rise to distressing symptoms analogous to the sprain of the large joints. Even when there is no injury to the bony structure or to the cord patients will suffer pain, distress on motion, and disability from the rupture of the ligamentous fibres connected with the spinal support. Many of these cases, combined with the nervous disorganization accompanying invalidism and following an injury, present functional symptoms not dissimilar to those seen in the traumatic neuroses. Patients of this class need careful treatment.

Sufficient amount of rest should be enforced to permit healing of torn ligamentous fibres, followed by such measures as will improve the circulation and diminish the congestion and local swelling following sprains. Massage, electricity, and gymnastic exercises (carefully graded) will gradually effect a cure.

Contusions and sprains of the trunk following railway accidents present certain features. From the medico-legal complications to which railroad injuries often give rise, the symptoms vary greatly according to the condition of the patient, and are often complicated with studied exaggeration and malingering.

The SYMPTOMS are at first those of a contusion or sprain, followed by those which result from the confinement after an injury, and resembling those seen in neurasthenia and general invalidism. These are recognized by their varied and ill-defined character, unlike those of a true organic lesion. It is often necessary that the injury should be treated at first as if a severe contusion were present : after the lapse of sufficient time for recovery from any traumatism, if symptoms still are present, they should be treated as neurasthenic cases are treated, by muscular development and stimulants to the circulation, muscle-building, and nerve-training. These cases are not to be confounded with those of true malingerers, where recovery takes place immediately after the verdict.

CONCUSSION AND CONTUSION OF THE SPINAL CORD.

The existence of contusion of the spinal cord has been questioned, but there is apparently no doubt that a severe lesion may take place in the cord without any external evidence of injury.

Gull has reported a case where death followed within fifty-five hours after an accident, with no external evidence of injury. At the *post-mortem* examination some small extravasations of blood into the anterior and posterior cornua and in the posterior columns were found. There had been complete paralysis in the upper and lower extremities. Hulke has reported a case where there was an imperfect recovery from paralysis, and Bastian has reported a case where death occurred six months after the accident, a fall of twenty-five feet. There was no evidence of fracture or compression upon the cord nor injury to the structure of the cord, but there were microscopic lesions in the substance of the cord, with secondary degeneration and atrophy of the sympathetic ganglia. These lesions had developed without external mark of violence. After the accident there was complete paralysis of motion in the leg and paralysis of the right arm. The patient had recovered somewhat after the injury, but contractions had persisted. The importance of these few cases lies in the fact that they appear to support the theory that although the spinal cord is carefully protected in the canal, both by the solidity of the structures which surround it and by the strength of the attachments which support it, yet in some instances of comparatively slight violence without external injury lesions in its structure may take place. It is difficult to explain the physical law by which such injuries are inflicted, but the facts cited seem beyond question.

SPINAL HEMORRHAGE.

Hemorrhage may take place in the cord or within its membranes— *i. e.* they may be extradural or subdural. It may also occur in the structure of the cord itself, a lesion termed *hæmatomyelia*. Gowers claims that this is a rare lesion, whereas Thorburn considers it not infrequent, and in examining 21 cases of injury to the spine found it in 6. It is more common in the cervical region. Where the hemorrhage is sufficient in extent to destroy the tissues paralysis and atrophic changes result. If, however, the lesion simply give rise to compression, the symptoms subside as the blood absorbs, leaving spastic symptoms in the lower limbs if degenerative changes have taken place. The attack is sudden, a distinct interval of time usually elapsing after injury, with paralysis and anæsthesia below the point of lesion and retention of urine and fæces. Where the hemorrhage is in connection with the membranes the lesions is termed *hæmatorrhachis*. It may be under the arachnoid, within the dura, or outside of the dura. (*Vide* Plate IV.)

Laminectomy has been performed for spinal hemorrhage, and, although the results up to the present time are not encouraging, yet the procedure is indicated in every instance where the patient's condition warrants any surgical intervention.

POTT'S DISEASE; SPONDYLITIS; VERTEBRAL CARIES.

Pott's disease, or caries of vertebral bodies, was first described by Percival Pott in 1779. It consists of a *destructive ostitis* affecting the spongy tissue of one or more of the bodies of the vertebræ. The ostitis is tuberculous, and is similar in character to tubercular ostitis seen in the epiphyses of the long bones. The changes in tubercular

PLATE IV.

4th C

5th C

6th C

7th C

8th C

1st D

2d D
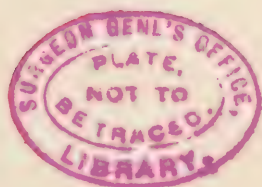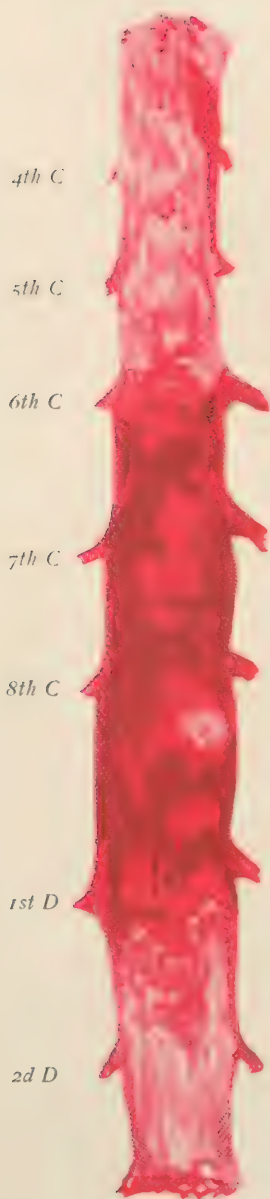
Intraspinal Hemorrhage, mostly Subdural, with Minute
Subpial Ecchymoses.   (Park.)

ostitis are described elsewhere in this work (Volume I. Chapter XXXV.).

Owing to the superincumbent weight of the head and shoulders pressing upon the carious vertebral bodies, the spine and trunk become peculiarly and characteristically distorted. The morbid process is limited, as a rule, to the bodies; the transverse, articular, and spinous processes are rarely primarily affected.

Tubercular ostitis of a vertebral arch has been reported by Roberts of Philadelphia. Primary disease of the intervertebral cartilage must also be extremely rare, if it exist at all. Various portions of the vertebral bodies may be affected. There may be two or more foci in one vertebra or the whole body may be affected. Disease of two vertebral bodies in different non-adjacent parts of the spine has been observed. The number of vertebræ involved in the extension of the morbid process necessarily varies: in some instances the bodies of twelve or even more have been diseased, with a distortion of the whole column.

The caries is aggravated by the pressure thrown upon the affected vertebral body; portions of the diseased bone become absorbed; the vertebral body becomes excavated or yields; the spine bends forward above the seat of the disease, and backward angular deformity at the point of disease results. This extends as more vertebræ are involved: the knuckle or projection is seen in the back; this enlarges and the so-called "humpback" results. This projection is to a certain extent modified by compensating curves in the healthy portions of the spine and alteration in growth in the shapes of the healthy bodies, and peculiar characteristic distortions result. The process may be arrested, the development of healthy bone take place, and a natural cure with deformity results; or the process may extend beyond the curative efforts of the cicatrizing ostitis, and necrosis with caseous foci and abscesses may result; which latter, extending to the adjacent tissues, discharge, forming sinuses, followed by prolonged suppuration with accompanying sepsis. Deformity inevitably results, with death in the severest cases, though ultimate recovery may take place even in cases regarded as hopeless. The ostitis extends to the adjacent tissue, involving the spinal canal and attacking the spinal cord and its membranes, giving rise to a *pressure paralysis*. This is not due to the narrowing or distorted shape of the spinal canal, except in rare instances, but comes as the result of an *external pachymeningitis*. Inflammatory thickening of the dura results; myelitis follows in certain instances, with ascending and descending secondary degeneration. The process may arrest itself, leaving no permanent change or a slight sclerosis, or the whole cord may be reduced to a fraction of its normal size. Paralysis may also be caused by the *pressure of an abscess*, and in rare instances by *loose fragments of bone*. In severe cases of angular deformity the chest becomes disturbed, with secondary pathological changes in the shape of various viscera. The shape and capacity of the chest are very much altered, and the ribs sometimes sink into the pelvis or rest upon the crests of the ilium. Hypertrophy of the heart may follow. Narrowing of the cavity of the aorta has also been noticed by Lannelongue. A cure, however, is possible even if the deformity be very pronounced, but the correction of a pronounced deformity cannot be effected.

Etiology.—Authorities differ as to whether the affection is more

common in males or females. The disease is probably equally frequent in the two sexes. It is much more common in childhood, beginning at the fifth year in nearly one-third of the cases. Gibney found that 87 per cent. were under fourteen years of age. It would appear, although statistics vary, that the theory advanced by Taylor is a plausible one—namely, that the regions most liable to disease are those most exposed to jars or increased pressure, and that the disease will be more frequent at the hinges of motion in the spinal column or where there is the greatest exposure to violent jars.

The determining CAUSE of caries of the spine is in all probability a jar or superincumbent pressure upon a tissue which is incapable of resisting slight injury, and which becomes thus exposed to the invasion

Fig. 31.

Fig. 32.

Caries in cervical region.

Caries in high dorsal region.

of the tubercle bacillus. Statistics as to an inherited predisposition or diathesis would indicate that an inherited lack of resistance is in many instances a factor in causation.

SYMPTOMS.—The symptoms of caries of the spine vary to a certain extent according to the portion of the spine affected. They may be classified as follows: First, those symptoms which are due to *irritation of the nerves* proceeding from the spine; second, those due to a *stiffness of the muscles* of the back and of the spinal column; third, to *peculiar-*

ity in attitudes from the inability of the spine to bear superimposed weight.

Typical cases of Pott's disease are so characteristic that the DIAGNOSIS is evident at a glance from the singular deformity of the back; but in the early stages some experience is necessary in recognizing the affection. *Peculiarity of attitude* due to muscular stiffness, *referred pain,* or *nervous disturbances* are then prominent early symptoms, and may be present before a projection has been noticed. The peculiarity of attitude is due either to reflex muscular spasm similar to that seen in joint dis-

FIG. 33.
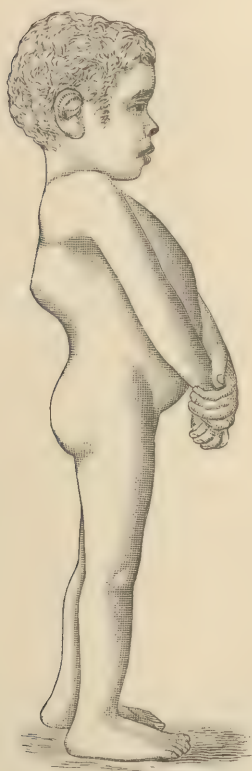
FIG. 34.

Caries in mid-dorsal region.

Caries of spine, with psoas contraction and old sinuses.

ease, or to an unconscious effort on the part of the patient to prevent jar or any increased pressure upon the affected vertebral bodies. This attitude necessarily varies according to the point of the spine attacked. In the upper cervical region it resembles that of wry neck; in the lower cervical or upper dorsal region the chin is held somewhat raised and the spinal column below the point of disease is straighter than normal; in the middle dorsal region the attitude noticed most frequently is an elevation of the shoulders, sometimes with one held higher than the other, and some lateral deviation of the spine; in the lower dorsal or lumbar

region the patient, in the early stage, will be frequently noticed to lean backward. The patient walks upon the toes, with the knees bent so as to diminish the jar of the spine. These peculiarities of attitude vary according to the severity of the disease. They may be at one time more noticeable than at another. A certain amount of muscular rigidity of the muscles of the back will be found on palpation, and it will be noticed that children become more easily tired, and after playing for a while will desire to lie down, rest their arms upon a chair, or support the head with their hands. The amount of muscular stiffness and rigidity is, in a measure, an index of the degree of activity of the disease. In addition to the spasm of the muscles of the back, the attitude is affected by contraction of the psoas muscles and in such cases as present psoas contraction : abscess, beginning or developed, is to be suspected. In the early stages this contraction is slight, but as the disease progresses it may be present to such an extent that locomotion on the leg is difficult. Double psoas contraction sometimes occurs, crippling the patient.

Pain may be present in Pott's disease to a very severe degree, but, as a rule, this stage is only temporary, and in some cases pain is entirely absent. The pain complained of is not in the back, but is referred to the peripheral ends of the nerves in the cardiac, abdominal, or epigastric region, or frequently in the thighs and legs. In caries of the cervical region it may be referred to the back or to the top of the head. The pain is ordinarily slight, aggravated by jar, and may be only occasional, but severe attacks accompanied by hyperæsthesia are sometimes noted.

Analogous to these attacks of pain are disturbances of other nerves, manifesting themselves in dyspnœa with cyanosis, digestive disturbances, nausea, vomiting, and troubles of the bladder. These attacks may subside, and recur at intervals without apparent cause. Tenderness on pressure over the spinous processes is rarely present. When tenderness of the back is observed, it is more an evidence of functional neurosis than of caries. Tenderness of the spine may occasionally be observed in Pott's disease from a general hyperæsthesia. This, however, is diffuse and not sharply localized.

Paralysis in caries of the spine may be present at any stage of the disease. It is sometimes partial, but may become complete paraplegia. Out of 295 patients with caries of the spine, Gibney noted paralysis in 62. In 189 cases of caries of the upper dorsal or cervical region, paralysis occurred in 59. In 106 cases of lower dorsal and lumbar caries, paralysis occurred in only 3.

Deformity in Pott's disease is characterized by the backward projection of one or more spinous processes. This is due to the carious disease of the vertebral bodies forming the anterior support of the spine. The spinal column above the disease falls forward, throwing certain of the spinous processes into prominence, and thus causing a projection of one or more of them. The adjacent vertebræ become more or less involved in the disease or altered in shape from the altered pressure, it being found, as a rule, that as the projection is sharper the disease is more acute. The deformity tends to increase until either a spontaneous cure results or until the carious bone has solidified by cicatrization. The deformity may involve the whole of the dorsal region, and cause also an unsightly dis-

tortion of the chest. This consists of a thrusting forward of the sternum, with a projection of the lower portion of the sternum and abdomen, giving a contour caricatured in the well-known traditional figure of Punchinello.

Abscess is a frequent complication of Pott's disease. Caseous foci extending from the diseased bone may cause sufficient irritation to form an abscess, which, projecting from the vertebral bodies into the thorax or abdomen, extends down under the fasciæ and comes to the surface in various regions. In the *cervical* region, abscess may point in the throat (*retropharyngeal*) or in the neck. *Dorsal caries* may develop *thoracic* abscess, evacuating itself in the lung or passing through the muscles and pointing in the back or sides. The most common place, however, for abscess in Pott's disease is in the *inguinal region* or in the *groin*, passing under Poupart's ligament and developing in Scarpa's triangle—the classical *psoas abscess*. Before passing through Poupart's ligament, abscesses may accumulate in the inguinal region, dissecting up the peritoneum and presenting a large subperitoneal abscess. The contents of such abscesses are pyoid or sero-purulent fluid containing caseous masses. Frequently calcified or bony spiculæ are present, and in some instances the contents are cheesy, with but little fluid. Abscesses may be absorbed and disappear. In a majority of instances, however, abscesses press to the surface and ulcerate through the skin, and thus evacuate their contents. If they open spontaneously in such a way as to be completely evacuated, they may eventually heal, but in many instances the contents are only partially discharged. Some caseous matter remains, and, although the external opening of the sinus is closed, a later reappearance of the abscess may take place. In other instances the discharging sinuses persist with pent-up pus, and eventually exhaust the patient by the accompanying septic processes.

DIAGNOSIS.—The early recognition of Pott's disease is of the utmost importance. The diagnosis where marked deformity is present is easy. A backward projection of the spinal column from the median line of the spine is pathognomonic. The curve in chronic rheumatic arthritis, rickets, aneurism, or malignant disease is round, entirely different in appearance from the sharper angular projection in Pott's disease. In severe scoliosis the trunk may be as badly distorted as in Pott's disease, but the humpback is a projection of the rotated and distorted ribs and not of the spinous processes.

In examining the patient at an early stage the child should be entirely undressed, made to stand upon a table or to walk across the room ; the position in which the child holds itself, the gait in walking, the attitude in stooping to pick something from the floor are to be carefully noted. The patient should then be laid upon its face on a table or hard bed, and the flexibility of the spinal column tested by lifting the child's feet and legs with the face downward. The child should also be turned upon the back. The backward extension of each thigh should be examined to determine whether any projection of psoas muscle on either side is present. The abdomen should also be palpated in the inguinal region. Where cervical caries is suspected the attitude and movements of the head should be carefully noted. The patient should be seated upon a lounge or the floor and directed to bend forward so as to touch the toes

with the hands if possible, and at the same time bowing the head forward so that the chin should touch the chest. The normal flexibility of the spine varies in individuals, and in children it is much greater than in adults. The forward and backward flexibility is greatly diminished where caries of the spine is present, even at an early stage of the disease. Stiffness in rotation of the spine should also be examined by causing the patient to turn while the pelvis is firmly held. Where caries of the spine in the dorsal region is present stooping forward to pick anything from the floor is difficult, and only done by holding the spine in a stiff position quite characteristic of the disease. This is not true, however, in

Fig. 35.

Test for stiffness of the spine: normal flexibility.

caries in the cervical region except in the more acute stages, at which time disease is unmistakable from the presence of other symptoms. The peculiarity of attitude in early stages of Pott's disease may be noted as a torticollis, a lateral deviation of the spine, an unusual attitude with raised chin and elevated shoulders, bent knees, or an exaggerated backward bending at the lumbar region, varying with the portion of the back affected.

The *seat and localization of the pain* and nervous symptoms are characteristic, more in connection with other symptoms than from anything noticeable in the pain itself. They are ordinarily classed by the parents

and attending physicians as rheumatic or neuralgic attacks. A grunting respiration and frequent belly-ache, continuing at intervals for a long period, are both significant.

The *recognition of a projecting knuckle* in the earliest stages of Pott's disease is not always easy. In the cervical region the muscles may be thick and the projecting spine masked. The sixth and seventh cervical spines are normally prominent, and frequently the first dorsal also; the last dorsal and the first or second lumbar are often more prominent in health than the other spinous processes. These projections, however, are not sharp and do not interfere with forward or backward flexibility. Any projection of the spine in the middle dorsal region should be regarded as a symptom of great significance, as a physiological projection of one of the spinous processes in the mid-dorsal region is not observed. Peculiarities in the line of spinous processes are to be seen in lateral curvature, and in some instances of cancer and sarcoma of the spine, in aneurism and rhachitic curves of the spine in small children. The first is easily distinguished from Pott's disease by the twist or rotation of the spine, while rhachitic curves are rounded. This is also true of the spinal curves due to carcinoma, sarcoma, and aneurism of the spine.

The *recognition of paralysis* is not difficult after it is developed; beginning paralysis is sometimes overlooked. It is characterized by exaggeration of reflexes, knee-jerks, and ankle-clonus. Abscesses are recognized in the early stage by palpation and the recognition of psoas contraction.

Pott's disease may be confounded with *traumatic neuritis* of the spine (railroad spine), *hysterical spine, rheumatoid arthritis,* and *sacro-iliac disease.* Other mistakes in diagnosis have occurred, but are due more to an ignorance of the ordinary symptoms of Pott's disease than to any inherent difficulty in the diagnosis itself. Mistakes in diagnosis between low caries and acetabular hip disease have been made, but can be avoided if it is borne in mind that in hip disease flexion in abduction of the lame thigh is interfered with, while in caries of the spine motion in abduction is as free on the lame as on the other side; and this is usually true of flexion.

A distinguishing characteristic of *traumatic neuritis* of the spine or the neurasthenic or hysterical spine, as compared to Pott's disease, is that in the so-called functional affections local tenderness in the back is usually present, but is almost invariably absent in Pott's disease. In rheumatic arthritis the stiffness of the spine is not sharply localized, but involves nearly the whole column; there is usually little muscular spasm, no unusual projection of the spinous processes; the ribs are ankylosed to the spine, and a full expansion of the chest is interfered with or the amount of expansion is noticeably limited.

PROGNOSIS.—Caries of the spine is necessarily a disease of long duration. It involves a severe deformity unless checked, and is attended by severe complications, paralysis, and abscess, and at times alarming symptoms. Facts, however, show that the disease has a tendency to recovery in many cases, but with the development of deformity. Under thorough treatment deformity can be prevented, the symptoms relieved, and patients entirely cured. Pathological specimens, however, show

complete bony union and an entire cessation of the carious process, and clinical evidence in abundance can be cited to prove complete recovery in a large number of instances (Fig. 36).

In the autopsies at the Munich Pathological Institute on patients with Pott's disease 24 out of 31 were found to have hypertrophy of the right side of the heart; 4 had muscular degeneration of the heart-walls; 2 had stenosis of the mitral valve; 1 showed acute miliary tuberculosis; 8 died of phthisis, 4 of pneumonia, and 1 of carbuncle. In one of Lannelongue's specimens of stenosis of the aorta following Pott's disease the aorta only measured 16 mm. at the origin of the brachio-cephalic trunk, 12 mm. after the carotid had been given off, and only 8 mm. in the region of the second lumbar vertebra. In another specimen the lumen of the aorta was reduced to a mere slit.

The prognosis of abscess depends largely upon the situation of the abscess and the possibility of complete evacuation. The prognosis in adults is not as favorable as in children. The tendency of the deformity is to increase during the period of activity of the disease, as well as in the period of growth of a twisted spinal column—a tendency especially marked in the upper dorsal region. Cases of arrest of the disease and spontaneous cure without marked deformity occasionally occur in upper cervical and in lower dorsal disease, but in the upper and mid-dorsal regions the tendency to an increase of deformity is proportionate to the extent of the disease. In some cases arrest of growth of the whole child takes place, apart from the loss of vertebral substance. This is especially true in upper dorsal disease. A peculiarity in the shape of the face is also seen in cases with severe deformity of the trunk.

FIG. 36.

Spinal curvature with exaggerated deformity : recovery by ankylosis (Park).

Paralysis in Pott's disease *shows an unusual tendency to recovery.* Taylor and Lovett found that of 59 cases analyzed, 39 recovered entirely, 3 recovered in part, 5 died of an intercurrent affection, and in 12 the termination was not known. Where the bladder and rectum were paralyzed the percentage of recoveries was much smaller. The average duration of paralysis was somewhat less than one year. The disappearance of paralysis was gradual, recovery of sensation appearing first, then that of motion. The recurrence of paralysis occurred in a few cases. Marked paralysis of sensation indicates an extensive myelitis, but some impairment of sensation is found in a majority of cases. Paralysis of sensation may be marked, and yet recovery result.

TREATMENT.—As the course of Pott's disease is a long one, treatment through many years is necessary. The measures used, however, vary with the pathological conditions and the activity of the process. The principles of treatment of caries of the spine are simple, though their practical application is attended with difficulty. The diseased vertebral body should be protected from jar and pressure until a cure is accomplished. As in ostitis elsewhere, there is an effort toward repair, and everything should be avoided which would hinder this reparative process. The jars which come upon the spinal column are chiefly those received in bending the column forward, and pressure upon vertebral bodies comes from the superincumbent weight of the head and trunk. In treating a diseased vertebra the superincumbent weight should be removed from the part affected as far as is practicable, and all bending forward avoided. To prevent deformity the spinal column should be made as straight as possible and secured in a straightened position. A relapse will occur unless it be supported while the bone is not sufficiently solidified to endure a jar without reawakening an ostitis but partially healed. If the proper conditions are granted, it is possible to effect a cure without a deformity. Although it is sometimes difficult to secure the requisite conditions for a sufficiently long time, yet prevention of the increase of the deformity in all cases, and even diminution of slight deformity in some instances, can be gained by thorough treatment.

The **methods of treatment** may be grouped as—first, **recumbency**; second, the **use of appliances or corsets**.

Recumbency.—If the patient lie upon the back or upon the face on a hard surface, there is no superincumbent weight pressing upon any portion of the spine. If the patient lies upon his back upon a sagging bed, the spine is bent and some pressure upon the vertebræ results, though the superimposed weight is removed. For this reason it is not sufficient in treating caries of the spine by recumbency that the patient be placed in bed : the spine should be held in such a position that the forward concavity of the column should be as slight as possible or obliterated entirely.

The method of treatment by recumbency has certain manifest disadvantages. It is irksome to the patient and the attendant. It removes, however, superincumbent weight entirely, and it is therefore of use in the acute stage for the purpose of preventing an increase of the inflammatory process, and of diminishing it by lessening the irritation from jar and superimposed pressure.

It will be found in practice that patients who have suffered from attacks of neuralgic pain during the painful stage of Pott's disease, will after a short period of thorough fixation become less restless and irritable, will gain in general condition, and be free from pain. It is difficult to secure sufficient fixation in the recumbent treatment without the use of some form of fixation frame. The *gouttière* of Bonnet, though admirable in its efficiency, is cumbersome and expensive. Its advantages can be secured by a light bed-frame, made as follows : Four strips of steel bar or four strips of ordinary gas-pipe half an inch in diameter are fastened together, making an oblong frame of the patient's height and width. The steel bars can be riveted at the ends or the gas-pipes can be secured in the ordinary gas-fitter's rectangular joint. This frame is covered tightly with stout cotton sheeting, wound about the frame, made tense, and secured at the sides. If this is placed upon a bed, the patient can lie upon it as comfortably as upon the ordinary mattress. The patient can be secured to this frame by straps about the shoulders

and hips and, if necessary, about the knees. The child can be lifted on the frame and carried about easily. The sheeting can be changed when soiled; an opening should be cut in the region of the buttock, so that the bed-pan can be used. A

Fig. 37.
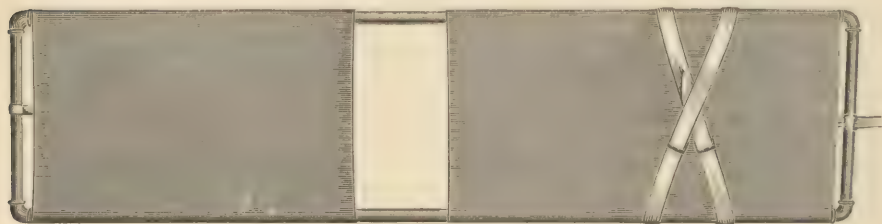
Bed-frame.

traction adjustment can be added at the ends of the frame. The great advantage of this apparatus is that the patient, while thoroughly protected from jar, can be

Fig. 38.

Child in bed-frame.

moved in an appliance that is neither cumbersome nor expensive. In the severest cases, in addition to the frame, fixation of the trunk by the employment of a plas-

Fig. 39.

Child in bed-frame, with head traction.

ter jacket or corset is sometimes advisable to secure the patient from any twisting in sleep. In ordinary cases, however, the frame alone is sufficient, but the use of pads placed under the back, pressing the spine forward, is of advantage. These

pads can be made of saddler's felting, and should be of sufficient thickness to raise the projecting portion of the spine. They should be placed at each side of the spinous process, and can be secured to the sheeting to prevent slipping. In cervical or high dorsal caries a light traction upon the head is of advantage. This can be made by a head-string fastened to the patient's head and secured to the top of the frame or to a weight-and-pulley attachment at the head of the bed; counter-pull is furnished by a belt secured to the lower part of the frame, or, if a weight and pulley is used, by raising the head of the bed.

Treatment by Plaster Jacket.—The most ready method of treatment of caries of the spine is by the plaster jacket introduced by Dr. Sayre. The advantages of this method are its ready applicability, its cheapness, and the fact that it places in the hand of every practitioner an efficient means of treatment. It cannot be said, however, that a plaster jacket is applicable to all cases of caries of the spine. It is a method which can be used with benefit in suitable cases. Some skill is required in application. A poor jacket does harm rather than good, and deceives the patient and the physician. In applying a plaster jacket the patient should be placed in the recumbent position or else in as straight a position as possible, with the curve corrected as much as practicable by suspension. Plaster bandages prepared in the usual way are wound around the patient's trunk, with the patient kept in a corrected position until the plaster has become hard. When the disease is situated in the mid-dorsal region the patient is firmly supported by this means. In the cervical or high dorsal region a plaster jacket is of use simply as a base for the support of some form of head-retention. The simplest

Fig. 40.

Jury-mast for high dorsal and cervical caries.

Fig. 41.
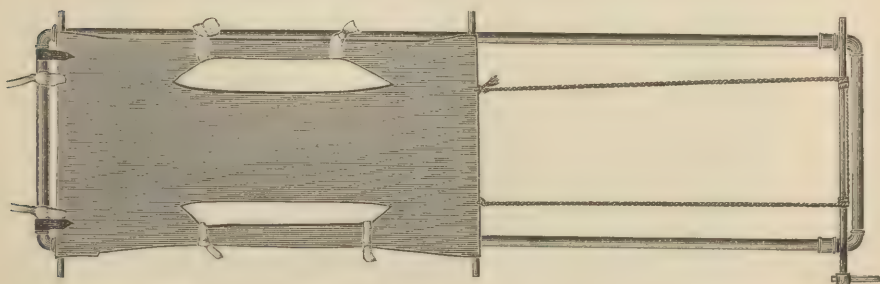
Frame for application of plaster jackets in recumbent position.

of these is what has been termed a *jury-mast*, which consists of a bent steel rod serving as a support for a head-sling. Instead of the jury-

mast, which is unsightly, an arrangement can be used supporting the head beneath the chin and occiput which is less of a disfigurement. In lower lumbar caries, where much lordosis is present, a plaster jacket

Fig. 42.
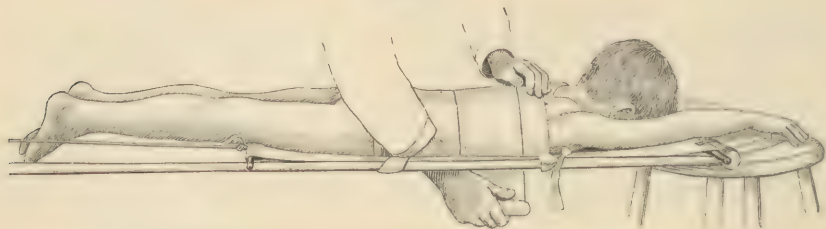
Application of a plaster jacket in the recumbent position.

should be applied, with the patient's back hollowed slightly in a position of lordosis and with but slight suspension to diminish to a minimum the intervertebral pressure.

Fig. 43.

Apron for antero-posterior support.

During the application of the plaster bandage the patient should either be suspended by the head or arms, or both, or a plaster jacket can be applied with the patient recumbent, lying face downward upon a tight sheeting support, like a flat

hammock. The hammock, made of stout sheeting, can be made tense by means of pulleys, and if slit, as is recommended by Brackett, along the patient's sides, the surgeon can apply plaster bandages snugly. When these are hard, the sheeting hammock is cut and can be pulled out from beneath the jacket.

The details of the application of the plaster are of importance. Projecting spinous processes or bony portions of the pelvis are to be protected by saddler's felt placed at both sides of the bony projection. The plaster should be well rubbed into crinoline free from glue or sizing, which will delay the setting of the plaster. The bandages should be well rubbed in as they are applied, and should be applied after having been thoroughly wet. If the details are properly attended to, the bandages become hard in a few minutes. Proper material should be used for the bandages. Cloth with too close a mesh cannot retain a sufficient amount of plaster, and holds moisture too long to admit of rapid hardening. Too coarse-meshed cloth, while allowing rapid setting, makes a jacket which is liable to crumble.

Plaster jackets are to an extent uncleanly, and for that reason uncomfortable; and occasionally an eczema will develop under the jacket, abscesses or chafes may be present, without attracting the immediate attention of the surgeon; but these

Fig. 44.   Fig. 45.

Thomas collar for cervical caries.   Head-ring, front view.

difficulties are to an extent obviated by skilful application and frequent renewal of the jacket. A plaster jacket can be split and lacing-hooks fastened to the sides of the cut, and the corset removed and reapplied at pleasure. This, however, does not furnish as firm a support as the unsplit bandage, and should not be used except in convalescent cases.

As a substitute for split plaster jackets, and their superior in durability, a corset of *leather* or *paper* can be made. This is shaped upon a cast taken from a plaster jacket used as a mould. Sole leather is wet, stretched, and hammered upon this cast, and thoroughly dried; if necessary, it can be strengthened by steel strips and fastened with the requisite lacings. *Paper jackets* are made by pasting upon the cast with white paste strips of thick matrix-paper thoroughly wet. Four to six layers of this paper are used; between each two layers strips of crinoline or linen are added, with a layer of crinoline inside and outside: the whole should be dried thoroughly, and the resulting corset split and removed from the cast. It can then be painted and varnished, and forms a stiff light jacket. Another form of jacket is made by the use of thin strips of wood fastened by glue. Corsets have been made of strips of steel woven wire and of aluminum. The latter are expensive, and hardly more serviceable than those of paper or leather.

Treatment by Means of Braces.—The treatment by means of braces has fallen into discredit from the fact that the application of spinal supports has been left too often to mechanicians whose object is more to sell their appliances than to cure the patient. Furthermore, the proper application of braces requires some experience and skill and attention to detail.

The brace consists of a strong steel support which is fitted to the back when the patient is recumbent, lying upon the face with a straightened spine. To this the patient is fastened by an apron carefully fitted in the front and secured to the brace behind by straps and buckles.

Fig. 46.

Wire head-support attached to antero-posterior splint for cervical and high dorsal caries.

The uprights of the brace lie on both sides of the spinous processes, and pads secured to a firm pad-plate are fastened to the uprights at such points as will bear the greatest pressure when the patient is erect. It will be seen after the patient is firmly secured, while in a recumbent position, to a firm steel brace, that in an erect position the amount of forward bending will be slight, the projecting portion encountering the resistance of a firm and unyielding brace. The successful employment of braces depends upon the careful attention to detail in the way of proper straps, pads, and buckles. The brace should be altered from time to time as the patient alters in shape. It will be readily seen that the stiffness of the brace should be sufficient to sustain a possible forward bending of the spine. Braces are often made light, allowing some spring, thus impairing their usefulness. It should be remembered that all possible forward bending increases the jar upon the affected vertebral bodies, and therefore is to be avoided. The attempt should be made to transfer, as far as is possible, the weight upon the articulating processes rather than upon the bodies. In the upper dorsal and in the cervical regions proper attachments are necessary for the support of the head. These attachments either consist of a jury-mast or, better, a circular ring or collar, which supports the head. When properly fitted these appliances are not unsightly, but their proper adjustment needs care.

Selection of Method of Treatment.—It should be clearly borne in mind that no one form of treatment is applicable to all stages of a disease nor to all cases. In the selection of the method of treatment the pathological condition should be carefully considered. In the acute stages absolute and complete recumbency should be enforced, and in such a position as will not only relieve the weight from the affected vertebral bodies, but diminish the pressure as far as possible. In the subacute and convalescent stage the erect position, which is essential for health, and therefore for the establishment of a reparative process, should be allowed, but only allowed when the back is firmly fixed in such a position as will as nearly as possible prevent any additional jar on the unsound vertebral bodies. Whether that should be done by some form of corset or of brace depends upon the amount of nursing facilities at the disposal

of the patient. Braces require more attention and more care. They are more precise, and therefore better, than a corset. In the mid-dorsal region, however, a carefully applied plaster jacket gives a support which is both firm and convenient, and requires no especial nursing. In the cervical and upper dorsal region braces are more effective than the corset and jury-mast, but require some skill in proper adjustment.

Treatment of Complications.—*Lumbar* and *iliac abscesses* constitute a formidable complication. Authorities differ as to the relative advantages of expectant treatment over that of early operation. The facts are, that a certain number of cold abscesses in the spine become absorbed if

Fig. 47.   Fig. 48.

Antero-posterior support: back view.   Antero-posterior support with head-ring for high dorsal caries: side view.

the carious process is arrested. In a certain number the contents tend to evacuation, and, if they can be thoroughly reached with the knife and suitably drained, this should be done. If, however, they are in a region where drainage by spontaneous opening is more thorough than that given by early operation, the expectant treatment should for a time be employed. Where abscesses become large they need to be opened, and this should be done by a free incision under aseptic precautions. In *lumbar abscesses* the opening should be made in front and back by an incision in front, above Poupart's ligament, near the anterior superior spine, and behind in the region between the ribs and iliac crest.

The Treatment of Psoas Contraction.—This deformity should be treated by *correction under an anæsthetic* or by traction by means of weight and pulley. In resistant cases osteotomy may be necessary.

Paralysis.—The natural course of paralysis is toward recovery, and the use of medication is therefore of uncertain value. The same is true of the actual cautery, recommended by the earlier writers. In some instances laminectomy is of advantage, but exact value of this procedure in Pott's disease is not as yet determined. In view of the fact that the percentage of recovery of cases properly treated is nearly 100 per cent., the advantages of laminectomy can only be urged where thorough treatment has been tried and failed, where care cannot be furnished for a sufficiently long period to establish a cure, or where the patient is becoming worse after a long period of careful treatment.

Acute Osteomyelitis of the Vertebræ.

This affection, which differs clinically from tuberculosis of the vertebræ or Pott's disease, has been described by Tournadour, Lannelongue, Witzel, Stanley, König, Valleix, Huron, Deaver, Lloyd, Chipault, Morian, and Keen. The invasion is, as a rule, more violent than in caries; there is more fever and muscular spasm of the muscles of the back; later there are swelling and suppuration. In a third of the cases the arches are attacked. In the cervical region the head may be drawn back as in cerebro-spinal meningitis; later there are swelling and pain in the region of the spine. In some cases there is paralysis of some of the limbs, varying with the portions of the nerves attacked.

Diagnosis is not always easy in the early stages. Where it is possible for a diagnosis to be made the treatment by direct incision, disinfection of the parts affected, and drainage, recommends itself. In many instances, however, the expectant treatment is necessary from an inability to recognize the disease. The disease is a dangerous one, but spontaneous recoveries have been reported.

Cases have been reported by Gibney, and also by Osler, with symptoms referable to disease of the spine following typhoid fever. The "typhoid spine," as it is termed by Gibney, is perhaps an osteomyelitis following typhoid fever, or an affection resembling osteomyelitis with less acute invasion than in the instances hitherto reported. (*Vide* Volume I. Chapters XIV. and XXXV.)

Curvatures of the Spine not Due to Primary Bone Disease.

In addition to what is termed angular curvature or Pott's disease, already described, there is common a **lateral curvature** or **scoliosis**, in which the spinal column is distorted by *curves due to faulty habits in attitude, paralysis,* or *weakness of muscles*. These curves are termed *kyphosis* (the curvature with a convexity backward) and *lordosis* (curve with a convexity forward). Strictly speaking, the angular curvature in Pott's disease is a form of kyphosis, but the term also includes other more common curves, especially the deformity known as *round shoulders*. This affection is usually the result of bad habits in standing and sitting, due either to muscular weakness, occupation, or in some instances

to *near-sightedness.* In rapidly-growing children the muscles of the back have not the required strength to maintain for a long time a correct position: the arms and scapulæ drop forward, and in order to balance this altered weight the patient leans backward at the waist, protrudes the belly, and throws the head somewhat forward, giving a stooping attitude. The same result is produced by those whose occupation obliges them to maintain a stooping position for many hours in the day.

In children with *rickets* or *paralysis,* owing to the weakness of the muscles a kyphotic attitude is assumed in a sitting position. In *rheumatoid arthritis* and *osteomalacia,* and sometimes in *malignant diseases* of the spine, the spine is *arched backward.*

In the early stages of curvatures without alterations in the shape of the bone, the spinal column can be made straight with but little difficulty. After a time, however, the bodies of the spine become altered, the ligaments adapt themselves to an abnormal position, and the curve becomes a fixed one.

In the early stage of round shoulders the curvature can be corrected by drilling the patient to maintain a correct attitude. If there be muscular weakness, special gymnastic exercises are of importance. Appliances are, as a rule, not advisable except in Pott's disease.

Lordosis.—The forward bending of the spine (convexity forward) occurs as a deformity often secondary to other conditions, such as congenital dislocation of the hip. It may result, however, from simple weakness of the erector spinæ muscles. The patient assumes this position in order to balance the trunk in such a way that the weakened muscles are not called upon to act. This is also seen

Spondylitis deformans, or rheumatic arthritis of spine.

in pseudo-muscular hypertrophy. It is seen also in early symptoms in Pott's disease and in children with large abdomens. Patients with ascites or abdominal tumors, as well as pregnant women, assume naturally this position. When the deformity exists in a mild form, due to a muscular weakness from overgrowth or from any non-organic cause, it is benefited by gymnastic exercises for the purpose of developing the lumbar muscles. In some instances a back-brace or a removable corset is of advantage to relieve the patient from the strain of the erect position, but it should only be used in exceptional cases and for a short time. Massage and electricity are useful as adjuvants.

Spondylolisthesis.—This term is applied to a rare affection which consists of the dislocation forward of the last lumbar spine where it articulates with the sacrum. A few cases of this has been reported. They were the result of the relaxation of ligaments after confinement. The use of a stiff corset and the employment of crutches constitute the treatment.

Spondylitis Deformans.

This name is given to *chronic rheumatoid arthritis of the vertebral articulations.* It is characterized by stiffness of the spine and a curvature with the convexity backward. In many instances it is accompanied by ankylosis of the articulations between the ribs and the spinal column, and in many, but not all, instances by rheumatoid arthritis in other joints. The affection is more common in old age, but is occasionally seen in children. It is to be distinguished from Pott's disease by the fact that the stiffness is not narrowly localized, and from a characteristic rounding in the curve, which is entirely different from the angular or sharp curve in Pott's disease. (*Vide* Fig. 49.)

The PROGNOSIS is not favorable.

The TREATMENT is similar to that in use for chronic rheumatoid arthritis elsewhere.

Operations upon the Spinal Column.

The operations which have been performed and recommended on the spinal column may be grouped as follows:

A. *Laminectomy:*
 1. To enter the canal, open the dura, and examine the injured cord and relieve the pressure of hemorrhage in case of hemorrhage;
 2. For the reduction of dislocation of the vertebræ or removal of spiculæ;
 3. For the removal of any tumor of the dura or any foreign body pressing upon the cord;
 4. As a means of examination and exploration of the vertebral bodies in Pott's disease.

B. *Operation upon the sacrum and coccyx.*

C. *Vertebral puncture* for the relief of excess of cerebro-spinal fluid.

Laminectomy.—The object of this operation is to relieve the spinal cord of any pressure which may be exerted upon it, with the least possible mutilation of the tissues involved in its structure. The indications for this operation have already been spoken of under the headings of Fracture of the Spine, Pott's Disease, and Spinal Tumors. The technical details, however, need special attention.

The *dangers* of laminectomy are chiefly those to be encountered from the depth and importance of the tissues and structures attacked. Horsley has called attention to the dangers of hemorrhage, and Keen lays special stress upon the shock following the operation. Especial care should be taken in administering the anæsthetic. The patient should be brought to the edge of the table, so that the face should project, and placed upon the belly or nearly so, with the face turned to the side, giving the anæsthetizer an opportunity to thoroughly inspect the face.

Incisions of different shapes have been recommended. A long, straight, median

PLATE V.
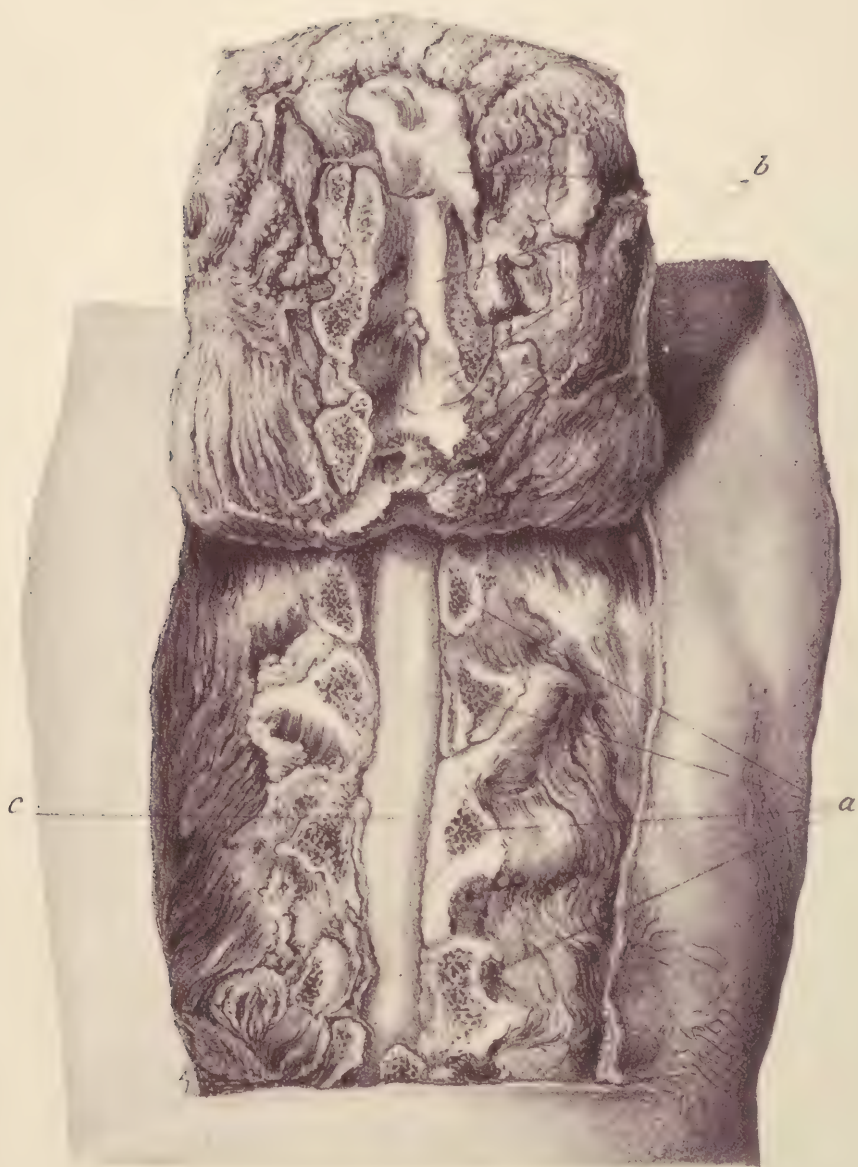
Osteoplastic Resection of Posterior Vertebral Arches.   (Urban.)

incision is, however, sufficient in all cases, unless an osteoplastic resection is attempted, when an inverted U-shaped incision is advisable. (*Vide* Plate V.) The skin, muscles, and fasciæ are to be divided, the spinous processes and arches laid bare: the muscles are to be separated from the arches by a knife rather than by raspatory. Time is not to be lost by the use of hæmostatic forceps unless large vessels are divided, which is ordinarily not the case. Hemorrhage is to be controlled by packing the wound, by pads, or by hot water. Osteoplastic resection, although advocated by some, is not to be recommended; the subperiosteal division, being shorter, is preferable. After the spinous processes and the arches are cleared attempts should be made to remove the bony tissue. For this purpose the saw, forceps, mallet and chisel, and the trephine have been used, but the simpler the

FIG. 50.

Specimen of laminectomy of spine (Warren Museum).

method the better. The periosteum is to be pushed back from the spinous processes and arches as far as possible, and by the use of a pair of strong bone-forceps, made for the purpose with a flat plate on the under side, the arches are to be divided on each side, care being taken to avoid wounding the dura or the nerves as they emerge from the spinal column. It is necessary to remove several laminae, the size of the opening into the canal depending upon the amount of the cord it is necessary to expose. Fatty tissue will be found lying in the canal. It can be separated by blunt dissection; the dura is freed from the canal by means of a director, and the cord felt through the dura. In case of extradural lesions, these can be inspected, and the condition of the dura and the contents of the spinal

canal determined. It is advisable, if possible, to avoid opening the dural cavity. When it is necessary the incision of the dura should be a straight, median incision. After the operation, in case any is needed, the dura should be closed by sutures, the muscular flaps brought together, and the skin sutured. It is advisable to drain the wound for a few days by means of a gauze wick, as considerable oozing follows the operation. No drain, however, should be inserted within the canal. In some instances it is desirable to suture the muscles and ligaments. A bed-frame after the operation, or a fracture-bed, will be found of assistance. Patients lie most comfortably upon the back after the operation : lying upon the face facilitates attention to the wound and obviates the necessity of turning the patient for that purpose, but does not permit of as complete drainage of the wound as a position upon the back.

Attempts have been made to reduce the deformity following fractures or dislocations by cutting down upon the spinal column and forcing the displaced fragments into position ; but such a procedure is of doubtful efficacy. Spiculæ of bone can be removed—the condition of the bone examined. Correction of the malposition is to be effected when possible with much circumspection to prevent further injury of the cord or nerves.

Laminectomy in Pott's Disease.—The spinal canal is opened in caries of the spine to relieve the cord from pressure, and laminectomy for that purpose does not differ from the ordinary procedure. It has also been recommended as a means of examining the condition of the vertebral bodies. This can be done by separating the dura from its bony attachment in the canal, using a curved director for the purpose, and exploring the posterior surfaces of the vertebral bodies by means of a probe or director, pushing the dura and cord gently to one side. It is not always necessary that a complete laminectomy should be done for this purpose : opening the canal by removal of the arches on one side will be sufficient unless more room is required.

Measures have been recommended for the *examination of the vertebral bodies without entering the vertebral canal.* This is of value in wounds of the spinal column without injury to the cord for the examination of the bodies in tubercular ostitis, as well as in osteomyelitis. The technique varies in different parts of the spinal column—viz. in the lumbar region, in the dorsal, and in the cervical region.

Lumbar.—This procedure was described by Treves in 1884 as follows :

A straight incision is made from the last rib to the ilium, $2\frac{1}{2}$ inches to the outside of the median line ; the incision reaches to the border of the quadratus muscles, and the tips of the transverse processes should be felt ; careful dissection should be continued down to the psoas muscle. The peritoneal cavity is not to be opened. By means of large retractors, such as are used in nephrectomy, the wound can be explored at its lowest depth, and by blunt dissection the side and anterior surface of the bodies examined by the finger.

Dorsal Region.—Boeckel in 1882, Hartman, Vincent, and others, have all recommended similar operations in the dorsal region. Schaeffer advises an incision to the side of the line of the spinous processes, which uncovers the tip of the transverse processes of the affected vertebræ and the head, neck, and part of the body of the corresponding rib. To avoid wounding the pleura, sympathetic ganglia, the spinal nerves, and the intercostal arteries, the rib is to be divided at the level of the tuberosity. The transverse processes are then to be removed, the bone being free from either attachment by blunt dissection. Vincent has suggested

boring from the side through the carious vertebral body and passing drainage through this opening.

Cervical Region.—It has been recommended to attack the vertebral bodies in the cervical region through the mouth. There are manifestly objections to this plan. The lateral method is much preferable; this can be done in the following way : An incision is made on the posterior border of the sterno-mastoid, the length depending upon the depth of the region to be attacked. The superficial veins and nerves are to be avoided as far as possible. The sterno-mastoid and omo-hyoid are to be raised, and the space bounded by the splenius, omo-hyoid, and posterior scalenus is reached; the longus colli is to be dissected through. Great care must be taken to avoid the vertebral arteries and nerves. Another method has been suggested, which consists of the incision at the level of the larynx, passing down to the lateral edge of the thyroid body close to the larynx, dividing the tissues internally to the common carotid. A small retropharyngeal opening is made, and this is gradually dilated.

The first of these methods is manifestly the better.

Wiring of the Spine.—Wiring of the spinous processes has been recommended and performed by Hadra. Ligature of the transverse processes, tying together of the laminæ, suture of the spinous processes, have also all been recommended after laminectomy and in cases of fracture, but have none of them found general acceptance.

Operations upon the Sacrum.—Operations for the opening of the spinal canal have been all recommended in the sacro-coccygeal region, but in this region a gouge, chisel, and mallet are to be used instead of the bone-forceps.

A long incision is made from below the twelfth rib, parallel to the median line of the sacrum ; the bone is chiselled through, and the anterior surface of the canal explored by means of the finger. The coccyx and lower part of the sacrum can be removed, piece by piece, using the rongeur forceps. The lower three pairs of nerves may be sacrificed if necessary, but the upper sacral nerves supplying the pelvic organs must not be touched. The operation is a tedious one, and there is much oozing of blood.

Removal of the Coccyx.—This operation is performed in obstinate cases of *coccygodynia*—*i. e.* painful or irritable coccyx. A median incision is made, the bone exposed, and the articulation of the coccyx with the sacrum cut through. The plexus of veins immediately beneath the coccyx is to be avoided as well as the rectum. The bone can be removed subperiosteally.

Vertebral Puncture.—This has been recommended by Quincke for the relief of *pressure* from an excess of cerebro-spinal fluid. A small trocar is thrust into the subdural space in the lumbo-sacral region, between the transverse arches or between the spinous processes of the adjacent vertebræ. In children the space between these parts of the adjacent vertebræ is comparatively large. The point of election is the third, fourth, or especially, the *fifth, space in the lumbar region.* The needle is directed toward the median line, entering outside of it—in children at the level of the space, and in adults at the tip of the spinous process. The first few drops of the fluid are slightly tinged with blood, but the remainder is clear. From 20 to 100 c. c. should be drawn off in an adult, and from 2 to 50 in a child. Rigid antiseptic precautions are necessary. The wound should be closed by iodoform collodion.

Fürbringer has tapped the vertebral canal in 86 cases, making the puncture in the second, third, or fourth intervertebral spaces in the lumbar part of the spine, using no anæsthetic, withdrawing as much as 110 c. c. of fluid in some cases: 37 of the cases were tubercular meningitis, and there was little benefit from the procedure. In serous meningitis temporary improvement followed the puncture. The procedure does not appear to be injurious, but is only of temporary benefit.

Tumors of the Spine.

The spinal column may be attacked by **malignant growths** in the same way as are other tissues. These tumors are those which either originate in the bone-tissue of the spine or in the adjacent tissues (Plate VI.).

Primary tumors of the spine are of the class which develop from connective tissue, such as fibroma, chondroma, myxoma, lipoma, sarcoma, and osteoma. *Secondary tumors* are those which come by metastasis, chiefly carcinoma, which is never primary.

Osteomata usually arise in the periosteum, though exostoses may develop directly from the bone. Fibromata usually develop from the periosteum, and exceptionally from the marrow. Chondromata and myxomata develop either from the periosteum or the soft bony tissue. There are many varieties of sarcomata of the spine—central, small round-celled, and chondro-sarcomata. Angeiomata are very rare. Osteomata usually are solitary tumors, but others may develop in different foci.

DIAGNOSIS of tumors of the spine can only be made after they have become so extensive as to be felt on palpation, or to have caused enough destruction of bone-tissue to interfere with the erect position, or to press upon the spinal nerves or the cord, causing obstinate neuralgia and paralysis.

The SYMPTOMS may resemble those of caries of the spine, and there may be a rounded projection of a few spinous processes.

Caries of the spine is most commonly a disease of childhood, the reverse being true of tumors of the spine in most instances.

Congenital Tumors of the Sacrum.

In addition to the tumors classed as spinæ bifidæ, or congenital cysts, there is a rare class which consists of vestiges of an attached fœtus. This varies greatly, from an ill-defined mass of tissue to a more or less completely developed structure like a dwarfed or deformed leg projecting from the sacrum. This can be amputated unless so firmly united with the pelvis that such an undertaking would be fatal. (*Vide* Vol. I. Chapter XXVI., *Dermoids.*)

Sacro-coccygeal Tumors at the Junction of the Coccyx with the Sacrum.

The most common form of these are varieties of spina bifida, already mentioned. They present themselves, however, in some instances slightly to the side of the median line. They are not always fluctuating, and may be dense, though it is characteristic of them that they vary in size from time to time. They are usually mistaken for fatty tumors, as in many instances they are covered by a thick layer of fat. Operative

PLATE VI.

Sarcoma of the Spine and Cord.　(Goldthwait.

interference with these cysts is too often fatal, owing to the difficulty of securing complete asepsis, from the constant escape of the cerebro-spinal fluid. Dermoid tumors originating in the embryonic remains of the post-anal gut have been already considered in Chapter XXVI. Vol. I.

Tumors of the Spinal Cord.

Of the various malignant growths which develop in the cord proper or its membranes, *gliomata* are the most commonly met, though fibromata, sarcomata, glio-sarcomata, and angeio-sarcomata are all reported, but very rarely. Multiple fibromata have been observed simultaneously in the cord and the peripheral nerves. Fibromata are usually round, and give rise to more or less degeneration of the substance of the cord in their immediate vicinity. Gliomata constitute tumors of oblong shape. They are usually situated around the central canal. Their substance is sometimes firm, though usually delicate, and they frequently contain cavities. They are sometimes rich in vessels.

Tumors of the Pia and Arachnoid.—Osteomata occasionally present themselves as small white disks. Angeiomata, from varicose enlargement of the veins, sometimes exert pressure on the cord and nerve-roots. Tumors of connective-tissue origin may also be seen in the pia as primary affections, while secondary growths, carcinomata, may rarely be found. As tumors in the spinal canal are confined in an unresisting cavity, they are of importance even when small, and their early recognition is essential for successful surgical interference.

The SYMPTOMS from tumors of the spinal cord vary greatly in their location, and according to whether they arise from the centre of the cord or from the dura and press upon the cord. *Pain* is usually present as an early symptom, but is not severe, and is frequently mistaken for rheumatism. This is accompanied by a certain amount of muscular or sensory *paralysis*. The pain increases *pari passu* with the tumor. It is rarely symmetrical, and in extradural tumors is always unilateral. Sometimes in tumors of the cord *muscular spasm* may be present in addition to pain, though this is a symptom which is more commonly seen in *intradural* growths. Horsley has called attention to the importance of the fact that the pain is not situated at a higher level than the tumor, and may be some distance below—a fact of importance in determining the point of opening the spine in operation. *Tenderness* at the seat of the tumor is frequently present, but in the dorsal region the tenderness is at a lower level than the tumor. Rigidity of the muscles of the spine may exist if the growth of the tumor cause irritation.

Tumors growing in the cord present a gradual development of symptoms. There is first *motor* paralysis, later *sensory* paralysis preceded by *pain*. The pain is at first neuralgic and lancinating; anæsthesia and pain in the lower limbs ascend gradually from the feet toward the trunk, and there is a dull ache in a distinct portion of the spinal column, accompanied by weakness at that point, which is increased on fatigue. The *reflexes*, deep and superficial, are exaggerated, and eventually lost, with symptoms of descending degeneration and wasting as the cord becomes diseased. The reflexes, as well as the pain and anæsthesia, begin in the plantar region and *pass upward*. The symptoms are not symmetrical, but are unilateral. Spasms and rigidity are present; the pupils are not affected. It should be borne in mind that there is a gradual loss of sensation or motion with intramedullary growths, while in the extramedullary growths the symptoms of

pain and spasm indicative of irritation may precede the paralysis. If the paralysis be of gradual development, preceded by long-continued symptoms of nerve-irritation, beginning on one side and gradually transferred to the opposite side, a probable diagnosis of compression of the cord by a pressure outside the cord can be made.

A DIAGNOSIS of the different varieties of tumor which may be developed in the spinal canal is clinically impossible. For the surgeon it is necessary simply to determine whether there exist any pressure upon the cord, and if this pressure be external to the membrane and capable of surgical relief, or a growth of the cord itself and inoperable.

The successful removal of tumors of the spinal cord belongs to the rarer feats of surgery, the difficulty lying not so much in the removal of the tumor as in the recognition of the affection at so early a stage that relief is possible. Chipault has collected 22 cases of operation on spinal tumors; Keen reports 3 more. The result of these operations was 11 deaths, 11 recoveries, and the result in 3 is uncertain. The operation is essentially a laminectomy, already described, plus the *enucleation of the growth.*

COCCYGODYNIA.

This name is applied to a *painful affection of the coccyx,* which in some instances arises spontaneously, but frequently dates from an injury, such as a fall or a blow, or comes on after childbirth. It is almost entirely confined to women, and usually appears in persons of a neurotic temperament. In many instances an irregularity in the coccyx can be found on palpation.

The TREATMENT should be at first that which is found efficacious in neurasthenic patients—massage, electricity, and stimulants to the circulation, such as an application of heat and cold, besides general tonics; in more obstinate cases *removal of the coccyx* is necessary. (*Vide* Operations upon the Spine.)

SURGERY OF THE PERIPHERAL NERVOUS SYSTEM.

SURGERY OF THE NERVES.

MOST of the affections of the nervous system belong strictly to the domain of internal medicine. There are, however, certain diseases which should be considered, in part, in a surgical treatise, from the fact that they are relieved by surgical interference. These are divided as follows:

I. **Wounds and injuries to the nerves.**

II. Diseased conditions calling for surgical interference, mainly—

   (1) Neuralgia;
   (2) Muscular spasm.

WOUNDS AND INJURIES TO THE NERVES.

Contusions of the nerves are not uncommon, either in dislocation or fracture or from direct violence crushing the tissues. *Constant pressure,*

as in the use of crutches ("crutch paralysis"), or lying in a peculiar position with the arms under the head for a long period, as occasionally happens in intoxicated persons, sometimes produces changes which may be classed as injuries. An injury of the nerves is recognized from the resulting impairment in the function of the nerve—*i. e.* motor or sensory paralysis.

All nerves are liable to injury, but lesions of a few nerves may be mentioned as not uncommon.

The *facial* nerve is often injured in fractures, gunshot wounds, or incised wounds, operations for removal of tumors, and blows. This is easily recognized by the appearance of the face: the eyebrow cannot be raised nor the eyelids entirely closed; the ala of the nostril on the paralyzed side does not move in respiration, and control of the angle of the mouth is diminished; the patient cannot whistle; the face on the paralyzed side is expressionless. The *ulnar* nerve is not infrequently divided above the wrist or at the elbow or in the upper arm. The flexor carpi ulnaris, the flexor profundus in its inner half in the forearm, and the whole group of the hypothenar muscles of the hand and the two ulnar lumbrical muscles, the interossei muscles, the adductor muscles of the thumb, and half of the flexor brevis pollicis are paralyzed. These muscles waste, and there is an atrophy of the hypothenar and a partial wasting of the thenar eminence. The position of the hand is characteristic, and what is termed a claw-hand results. The sensation following injury of the ulnar nerve varies. As a rule, the ulnar portion of the skin of the hand on the front and back, the little finger, and the ulnar half of the right finger are affected in injury to the ulnar nerve.

The *median* nerve, when injured, is chiefly disturbed above the wrist. The motor symptoms of injury to the median nerve involve all the flexors and pronators of the arm except the flexor carpi ulnaris and the ulnar half of the flexor profundus. If the median nerve has been divided high up, there will be paralysis of the muscles of the thumb except the adductor and half of the flexor brevis pollicis; the hand cannot be pronated by muscular effort; flexion of the thumb is lost, and the thumb cannot be pressed to the other fingers. There is more wasting of the forearm than in ulnar paralysis. There is no atrophy of the hypothenar, but there is of the thenar eminence. The anæsthesia includes the radial half of the thumb and palmar surface of the index and middle fingers and the radial side of the right thumb.

The *radial* nerve is rarely divided, and, as it is a sensory nerve, the sensation when the nerve is injured is imparted over the metacarpal bones and first phalanges of the thumb and fore finger.

The *musculo-spiral* nerve may be frequently injured in fractures of the upper arm or in gunshot wounds. The supinator longus muscle is paralyzed if the nerve be injured above the origin of this muscle, and wrist-drop results.

The *sciatic* nerve is rarely injured except in gunshot wounds. The external popliteal branch has been divided in tenotomy of the hamstring muscles. If there be an injury to this branch, the anterior flexor muscles of the foot are injured, and footdrop follows, the foot dragging when walking. If the sciatic nerve be divided or injured, all the leg muscles are paralyzed. The muscles of the thigh are not injured, and the patient can walk by throwing the leg from the hip forward. There is some impairment of sensation, but this is not as great as the loss of motion. There is loss of sensation in the foot and upper parts of the leg.

Division and injury to the *pneumogastric* nerve are rare. A few instances have been reported, and in the removal of tumors of the neck the vagus has been injured in a few cases. Roswell Park has collected 50 cases of injuries to the pneumogastric during operations upon the neck, and finds that the statement in older writers that this is a fatal accident is not warranted by the facts. He also collected 15 cases of accidental injuries of the pneumogastric. The result in 2 is not known, but of the 13, 2 recovered. He concludes, therefore, that injuries to the

pneumogastric are not, as has been said, immediately fatal. Wyeth suggests that if the pneumogastric or hypoglossal or other important nerves be divided, they may be sutured immediately, and Bloodgood is reported to have successfully sutured the pneumogastric. In most of the reported cases, according to Park, there were no symptoms directly following division of the vagus.

Cases of injury of the *phrenic*, however, are followed by severe dyspnœa, which in some instances is fatal.

NEURALGIA.

The subject of *neuralgia* belongs properly to a medical rather than a surgical treatise, and this is also true in regard to the medical treatment. In some instances, however, neuralgia is due to peripheral irritation, compression, or degeneration, rather than central or constitutional causes, and surgical interference is justifiable for the purpose.

Neurotomy, neurectomy, nerve-stretching, have all been employed for obstinate neuralgia, especially for the violent form of trifacial neuralgia.

Division of the nerve (neurotomy) for neuralgia, as well as nerve-stretching, does not give as satisfactory results as excision of a portion of the trunk—*neurectomy*. In some instances of trifacial neuralgia a permanent cure results, and temporary relief follows this procedure in all suitable cases.

Recurrence of pain is not infrequent, however, in the most obstinate cases, and recourse has repeatedly been had to removal of the Gasserian and other ganglia for relief.

MUSCULAR SPASM.

Operations upon the peripheral nerves are sometimes necessary for the relief of muscular spasm. The particular affection for which neurotomy, nerve-stretching, or, better, neurectomy, has been most often attempted is that spasm of the muscles of the neck known as spasmodic torticollis. Successful cases have been reported by Gairdner, Keen, Richardson, and others, but in some instances the operation affords little or no relief. Keen has recommended a division of the posterior cervical nerves on the opposite side, in addition to resection of the spinal accessory on one side. This has been done by the operators mentioned, and with success in some instances.

Operative interference should not be considered until after a thorough trial of all other measures. Of these, a complete rest of the muscles from the labor of supporting the head is of importance. Fixation of the head by a plaster bandage holding head and thorax, recumbency with light traction applied as in cervical caries, accompanied by massage and graduated muscular exercises, carefully prescribed and thoroughly carried out, present a rational form of treatment which is sometimes successful if persisted in for a long period. *Mechanical appliances* are of temporary assistance. A few instances have been reported by the use of *conium, atropine*, and *gelsemium*. In case of failure of all other measures, neurectomy of the spinal accessory, and, if necessary, of the posterior cervical nerves, gives some promise of success.

OPERATIONS UPON NERVES.

The operations upon nerves are *nerve-suture, nerve-grafting, nerve-stretching, division of nerves,* and *excision of parts of nerve-trunks.*

Nerve-suture.—Nerves should be sutured as soon as they are divided, if that be feasible (primary suture), even if the nerve be only partially divided. Two or three sutures are passed, not only through the sheath of the nerve, but also, if necessary, through the nerve itself, avoiding twisting the nerve-fibres. Fine catgut or silk should be used and a round needle. Fixation of the limb on a splint is advisable after nerve-suture in order that the sewn nerve should not be torn apart on motion. If there be separation of the ends of the nerves, they can be approximated by stretching, with fixation of the limb in such position as best to relax them. Suture can be also attempted weeks or months after the injury (secondary suture); the proximate end is ordinarily easily found from its bulbous termination, but the distal end is not so easily discovered. Recovery with restoration of function takes place in two-thirds of the cases operated upon. In 84 cases of primary suture reported by Howell and Huber, 42 per cent. were successful. In secondary suture the same writers report, in 80 cases, 38 per cent. of successes, 12 per cent. of failures, 50 per cent. with improvement.

Nerve-grafting.—Experiments have been tried in grafting nerves where the gap between the ends from a loss of the nerve-substance is so extensive that the ends cannot be approximated even by stretching. Reported cases of success by this method have been reported when the sciatic nerve of a dog has been used.

Nerve-stretching or Elongation.—A nerve can be *stretched one-twentieth of its length.* The amount of resistance to stretching is greater than would be imagined.

The sciatic does not break under a strain of less than 80 pounds; 6 pounds' pull is necessary to break the supraorbital nerve, according to Marshall. The amount of force required is greater in living than in dead subjects. The facial nerve will bear a strain of from 5 to 7 pounds, so that the head can almost be lifted from the table without a rupture of the nerve-trunk.

The theory as to the benefit of nerve-stretching is that changes in nutrition follow, while adhesions to the neighboring parts or to the sheath are destroyed. Nerve-stretching is done by *exposing the nerve and loosening it* from the surrounding tissues: it is then *stretched* by hooking it under the thumb, or in some nerves, as the seventh, by a button-hook. Nerve-stretching by what has been called the *bloodless method* has been employed on the sciatic nerve. This consists in flexing the thigh forcibly upon the trunk, the leg being kept straight at the knee while the patient is under an anæsthetic. The method lacks surgical precision, although some cases have been reported where benefit has followed. Nerve-stretching has been used in certain cases of spasm of the facial muscles and in wry neck, but the benefit of this procedure is usually only temporary.

Neuroplastic Surgery.—This has been advocated as a substitute for nerve-grafting. A portion of the severed nerve at each of the cut ends is split and freed nearly to the termination; these strips of nerve are folded over and their unattached ends stitched together. This method is as yet in an experimental stage.

Operative Details.

The operative details for the finding and resection of the different nerves require especial attention in each individual case. The few following facts are to be borne in mind by the surgeon in considering operations upon the nerves and nerve-structures most commonly attacked:

The Supraorbital Nerve.—A curved incision, an inch in length, is made across the orbital notch, which can usually be felt. The incision can be made in the eyebrow and the scar will be hidden by the hair.

The Division of the Fifth Nerve at the Superior Maxilla.—The *infraorbital* nerve comes to the surface at the infraorbital foramen. This is found at the intersection of a line drawn from the superior orbital notch downward between the two lower bicuspid teeth. A curved incision one and a half inches long is made just below the lower border of the eye: where this incision meets the line already mentioned the nerve will be found. It lies under the levator labii superioris. The nerve can be lifted from its bed by a hook and dissected as far back as the orbit. A pull upon the nerve will remove nearly the whole of it.

The Removal of Meckel's Ganglion.—This ganglion can be reached by Chavasse's modification of Carnochan's method. This consists of an incision below the eye, T-shaped, the cross portion reaching from one corner of the eye to the other, and the upright nearly to the mouth. The infraorbital nerve is found and tied with a piece of silk. The antrum is opened by means of a trephine or chisel: a trephine is applied to the posterior wall of the antrum; the nerve is then drawn down after being divided from the cheek, and will serve as a guide to the ganglion, being pulled into the spheno-maxillary fossa of the foramen rotundum. Horsley does not trephine the antrum, but lifts the floor of the orbit, including the periosteum, and opens the canal by means of a sharp-pointed bone-forceps, and follows the nerve to the foramen rotundum. Luecke resects the zygoma, turns the temporal muscles up, and makes an opening for the ganglion.

Inferior Dental.—This nerve can be reached in several ways. An incision two inches long is made along the lower border of the jaw; the flap is pushed upward, the masseter muscle being separated from the jaw, and a trephine is applied one and a quarter inches above the angle of the jaw. The nerve is then exposed.

Removal of the Gasserian Ganglion.—The removal of this ganglion has been done in cases where the ordinary neurectomy has not given relief. This ganglion is removed in the following manner: The eyelids are sewn together for three days in order to protect the eyeball; a curved incision is made half an inch below the external angular process of the orbit, along the zygoma, to its posterior end, then downward to the angle of the jaw, and finally along the lower border of the jaw as far as the facial artery. This flap is brought forward; the zygoma is first divided and turned downward with the attachments of the masseter muscles; the coronoid process is divided and brought upward with the attachment of the temporal muscle. The internal maxillary artery may be ligated and the external pterygoid separated from the sphenoid and the external pterygoid plate. A half-inch trephine is applied in front and slightly to the outside of the foramen ovale, with the edge of the trephine just touching the foramen ovale. There is usually considerable hemorrhage. A strong light is advisable. In the first instance the eye was destroyed, and had to be removed. In later cases, however, this has not been the result. Mr. Horsley, instead of attempting to remove the entire ganglion, which he says cannot be done without opening the cavernous sinus, trephines and removes the squamous portion of the temporal bone, opens the dura, ligates the middle meningeal, lifts up the brain, and exposes the roots of the nerve as they pass to the Gasserian ganglion. These lie in a canal a quarter of an inch in diameter beneath the tentorium, which should be opened. The nerve-roots are cut and drawn away from the pons. This operation has never been done but once, and then with a fatal result. Mixter has resected the second and third divisions at both the foramen rotundum and ovale, and has done the operation successfully several times. He makes an incision similar to that for removal of the Gasserian ganglion. The temporal and pterygoid muscles are separated and turned down, using an incision which has been described by Salzer.

Park has advised a preliminary ligation of the common carotid as a great help, no matter which method of attack be selected.

Lingual Nerve.—This has been operated on to diminish pain in cancer of the tongue. The nerve lies on the floor of the mouth beneath the mucous membrane, and can be felt if the tongue be forcibly stretched. The mucous membrane is incised and a hook is passed under the nerve. The nerve can also be found as it lies in the tongue close to the first molar of the lower jaw.

FIG. 51.
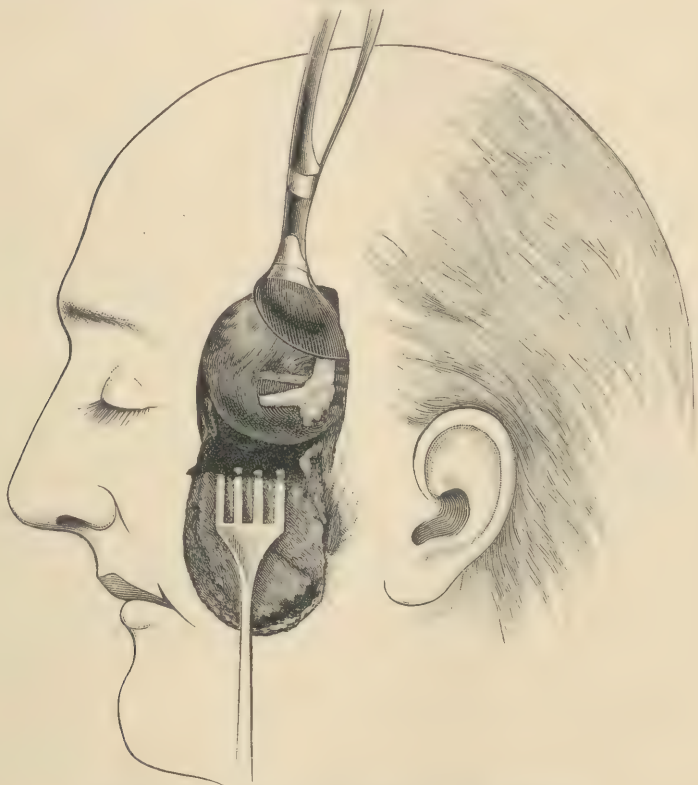
Exposure of Meckel's or the Gasserian ganglion (Krause).
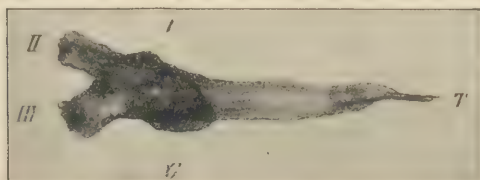
Fragment removed from the fifth nerve.

The Seventh Nerve.—This nerve is reached by a vertical incision two and a half inches long made behind the ear: the parotid is found at its posterior limit and is turned forward; the sterno-cleido insertion is then found, and in the space between these two landmarks the prevertical muscles will be found. The inferior branch lies in front of the fasciæ covering these muscles, and crosses both the mastoid and the vertical ramus of the jaw. This nerve can also be found by an incision in front of the ear: one of the main branches is found in the parotid gland, and is followed back until the main trunk is reached.

Spinal Accessory Nerve.—This nerve is divided and excised for spasmodic

wry neck. It may be reached anterior to the sterno-cleido-mastoid, an incision being made along the anterior body of the muscle, passing two inches downward from the lobe of the ear. The muscle is turned to the outside, and the nerve can be found a little above the level of the hyoid bone. If it be desired to reach the nerve, as it is possible, from the sterno-cleido-mastoid, the incision is made along the outer border of the muscle, the centre of the incision being the centre of the muscle. The nerve will be found a little above this point.

Division of the Nerves in the Deep Posterior Cervical Plexus.—Keen divides the posterior branches of the first, second, and third cervical nerves in spasmodic torticollis which has been unrelieved by the incision of the spinal accessory. A transverse incision is made half an inch below the level of the lobule of the ear. The trapezius muscle is divided in the same line. The muscle is then dissected up and the great occipital nerve is found. The complexus is then divided, and the great occipital nerve is followed until its origin from the posterior division is reached. The suboccipital or first cervical nerve is excised. It lies in the triangle close to the occiput formed by the two oblique muscles and the posterior straight muscle. The exterior branch of the posterior division of the cervical nerve is found lower down, and should be divided close to the bifurcation of the main nerve.

The anterior branches of the cervical plexus may be reached by means of an incision along the posterior border of the sterno-cleido-mastoid muscle.

The Brachial Plexus.—An incision is made above the clavicle similar to that which is used for the ligation of the subclavian artery. The deep fascia is opened and the nerves will be found.

Median Nerve.—The same incision is used as for the ligature of the brachial artery. The nerve lies in front of the artery and passes from within outward. The median nerve can be reached in the forearm or the wrist. An incision two inches long is made on the inner side of the tendon of the palmaris longus. The nerve lies underneath the deep fasciæ. The branches of the median nerve to the thumb and fingers can be reached by an incision along the lower inferior border of the thenar eminence underneath the palmar fascia.

Ulnar Nerve.—An incision is made similar to that for the finding of the median nerve. The nerve lies farther back. It can be exposed behind the elbow, using an incision between the internal condyle and the olecranon. At the wrist an incision on the radial side of the tendon of the carpi ulnaris exposes the nerve, which lies under the deep fasciæ.

The Musculo-spiral Nerve.—An incision is made between the biceps and the triceps muscles. The deep fascia is opened, and the nerve is found in a groove in the interspace between the two heads of the triceps.

The Radial Nerve.—A longitudinal incision is made on the outer border of the forearm three inches above the wrist-joint.

The Great Sciatic Nerve.—An incision is made, four inches long, in the middle line of the thigh, beginning below the gluteo-femoral crease. The deep fascia is cut, the biceps is found, and the sciatic nerve will be seen at the outer border of the muscle.

Tibial Nerves.—The anterior and posterior tibial nerves are found through the same incisions that are required for ligation of the arteries.

Intraspinal Division of the Posterior Nerve-roots.—This operation has been done by Abbe in a case of inveterate neuralgia. Half of the arch of the fourth and the whole of the fifth, sixth, and seventh cervical arches were removed by Abbe in his first case. The dura was exposed, and the sixth and seventh cervical nerves were divided between the dura and the bone. Temporary relief followed. The operation has also been done by Horsley and others. It is more serious than operations on the peripheral nerves, and the results do not seem to be any more favorable.

TUMORS OF THE NERVES.

Nerve-tissue may be involved in malignant growths developed in the surrounding tissues, but primary malignant tumors of the nerves are rare :

they are sarcomata or gliomata. (*Vide* Vol. I. Chapter XXVI.) The term neuromata, a general one applied to enlargements observed in nerves, is unfortunate. The most common form of the neuroma is seen, after amputation, in the *bulbous enlargements* of nerve-ends which are involved in the surrounding tissue, though this can be more or less readily differentiated. A tumor may occasionally appear in the course of a nerve without apparent external irritation. This is due to an increase of the connective tissue which arises from the endoneurium, though sometimes from the perineurium, the axis-cylinder being there surrounded or its fibres pressed upon by the growth. These, are in fact, *fibromata* of the nerves. They are usually multiple and limited to certain nerve-tracts. Sometimes these tumors are sessile, and sometimes they have a pedicle. They may be found in the nerves of the skin, and are sometimes called fibromata of the skin. In very rare instances they may attain considerable size, even being reported as large as the fist. *Plexiform neuromata* consist of a thickened mass of nerve-fibres resembling somewhat a plexus of veins. The nerve-fibres are elongated and tortuous and increased in numbers. These form true neuromata, and may be found in the head or in any part of the body.

DISLOCATION OF THE NERVES.

Dislocation of nerves has been reported in a few instances. This is easily recognized by a movable cord which is felt under the skin, and by a sensation which the patient notices when this is pressed upon. Where no other means affords relief it is possible to cut down upon the the nerve and excise a portion, if it be not possible by section and suture to restore it to its place. Dislocation is most common in connection with the ulnar nerve at its passage back of the inner condyle.

CHAPTER III.

SURGICAL DISEASES AND INJURIES OF THE HEART AND PERICARDIUM, WITH SURGERY OF THE LARGE BLOOD-VESSELS; LIGATIONS.

By Duncan Eve, M. D.

Malformations of the heart are, fortunately, of rare occurrence, for the most part represent survivals of fœtal conditions, and pertain more to the domain of teratology than surgery, except as curiosities.

Absence of the pericardium, still more rare, is mostly associated with misplacement of the heart, and must not be confused with adhesion of the pericardium and consequent obliteration of the sac, which is so frequent in after-life. The acardiac fœtus can profit nothing at the hands of the most skilful surgeon; the defective arrangement of the valves and openings of the heart, limited entirely to a perpetuation of the conditions of fœtal life, is solely within the domain of pediatrics; and *thoracic fissures* (*fissura sterni*) resolve themselves into those in which, besides the sternum, the skin is also separated, in which case the heart is exposed (*cardiac prolapse*), and those in which the integument is not cleft, and when the heart is covered by it (cardiac hernia) are left to the ingenuity and originality of plastic surgery, which alone can determine the best mode of procedure.

Misplacement of the heart (*situs mutatus*) is also of rare occurrence congenitally, and the more important cases are merely a part of a general malformation of the body. The heart may be transposed, occupying a position on the right side of the chest; with this there is usually a transposition of other viscera, though it sometimes occurs alone. Or it may occupy the *middle line*, retaining permanently its position in early fœtal life. Misplacements from pathological conditions of other viscera and structures are more frequent. Thus the heart may be pushed down lower than normal by aneurisms of the aortic arch or the large vessels at the root of the neck or morbid growths occupying the upper mediastinum; it may be pushed too far to the left or right by pleuritic effusions or collapse of one or other lung; or it may be pushed too high up by abdominal growths or adjacent visceral hypertrophy, fluid accumulations, or gaseous development, the latter producing the greatest degree of displacement. These are all to be watched for by the surgeon in operations on the heart or adjacent structures, and with an ordinary knowledge of percussion and auscultation are readily detected, needing only bare mention here by way of precaution. The history of the case and a careful examination of the heart itself and adjacent structures generally suffice for a solution of the existing condition and its cause.

Wounds and injuries of the heart and pericardium have been, and are likely to be, of only too frequent occurrence. The well-known site of the heart has made it only too accessible to the death-dealing instrument of the suicide or assassin; its feebly protective surroundings, especially in front, leave it only too approachable to sword-thrust, bayonet, or bullet on the battle-field, or missiles and fragments projected by intentional or unavoidable and accidental force. Most generally, the exceptions being few and far between, lesions of any magnitude—and some quite slight ones, indeed—have and will prove fatal. Yet the history of the past has shown quite a number of slight and some severe wounds that have not been immediately lethal, and yet a few where life was prolonged indefinitely or determined by some altogether different cause. The number of favorable results in such lesions have been largely added to in the last thirty years, and it is to be hoped will yet be still more largely increased.

In "A Collection of Remarkable Cases in Surgery,"[1] made by my father, the late Prof. Paul F. Eve, M. D., nearly forty years ago, he collated from various authentic sources twenty cases of wounds of the heart, produced by various instruments and missiles ranging all the way from the musket-ball to a large sewing-needle, which may be briefly summarized as follows:

1. Mr. Lees (*Dublin Journ. Med. Sciences*, 1837). A pistol loaded only with powder, placed directly against the chest at apex of the heart; great depression, anxiety, sense of weight about the heart, tendency to fainting and severe palpitation, with recovery in a few days.

2. E. R. Maxson (in *Buffalo Med. Journ.*, 1831). Rupture of right auricle from lifting heavy weight; walked about the house the two following days; slight symptoms of dizziness at close of second day; on retiring to rest became thirsty, called for drink, and immediately died. Autopsy showed the rupture large enough to admit a crow-quill, and pericardium distended with coagulated blood.

3. J. H. McNicoll (in *Lancet*, 1852). Rupture of heart on getting up too soon after delivery; death in a short time—about half an hour.

4. Case of Duc de Berri. Opening of ventricle by dagger; Dupuytren in attendance, who kept the wound open; patient lived several hours.

5. Charles E. Lavender, M. D., report to Med. Ass'n of Alabama. Right ventricle penetrated by blade of knife; complete recovery—a most remarkable case, in which the rest treatment was faithfully carried out (1850).

6. Mr. Lees (*Dublin Journ. Med. Sciences*). End of sword passing through right auricle; death on second day.

7. *Ibid.* Wound of heart by fractured rib; death after some hours.

8. *Ibid.* Heart transfixed by iron stilet; patient lived twenty hours.

9. J. L. O'Connor, M. D. (*London Med. Gazette*, 1821). The heart transfixed by a darning-needle in an attempt at suicide; recovery.

10. Dr. Renauldin and M. Boujet (in *Patterson's Med. Register*). Death from pericarditis due to a needle introduced (suicidal) into the heart five days previously.

11. M. Trelat (*Bull. gén. Thér.*, 1846). A large needle removed from the heart after three days' sojourn in it without ill consequences; needle two inches long, and oxidized when removed.

12. J. McNeill, M. D. (*Med. Exam.*, 1849). Needle found in the heart upon dissection; had evidently been there more than a year.

13. Thomas Dorris, M. D. (*Am. Journ. Med. Sciences*, 1834). Lacerated wound of the heart by a fragment of wood; healing of wound; death on thirty-seventh day.

14. *Lancet*, 1846. A very important case reported by Mr. Holmes, in which the anterior wall of right ventricle was opened by a linear wound (gunshot) without perforation of pericardium; death soon after.

[1] Eve's *Surgical Cases*, 8vo, p. 858, 1857, J. B. Lippincott & Co.

15. L. Randall, M. D. (*Am. Journ. Med. Sciences*, 1829). Death sixty-seven days after gunshot wound from fowling-piece, three small shot found in right ventricle and two in right auricle.

16. Dr. A. Christison (in *Edin. Monthly Journ.* and *Rankin's Abstract*, 1853). A gunshot wound one inch outside of left coracoid process, passing downward into the thorax, received April 14th; death at the end of June following, and musket-ball found in left ventricle at apex, partly covered by a layer of white lymph.

17. *Schmidt's Jarbuch.* and *Br. and Foreign Med.-Chir. Rev.*, 1852. A ball found in right ventricle, having dropped down into it through pulmonary artery; death twenty minutes after reception of wound.

18. Dr. Latour. A soldier shot in the chest; great hemorrhage, which gradually subsided; wound cicatrized at end of three months, after which no inconvenience other than palpitations for three years; death six years after reception of wound, not due to palpitations; the ball was found in the right ventricle near its point, lying on the septum medium.

19. Dr. Finnell, N. J. (*Med. Reporter*, June, 1855). The prize-fighter Poole in a pugilistic encounter with Baker was shot with a revolver, and so far recovered that he wanted to renew his encounter on the fourth day afterward. Death twelve days later; ball found lodged in the septum between the ventricles, about one and a half inches from the apex of heart, and one-fourth of an inch from its surface.

20. Dr. M. Marini (*Med. Examiner*, 1844). The left ventricle opened by a dagger; death nine weeks afterward.

In addition eight other cases are cited in which the cavities of the heart were penetrated by bullet, 1; stab with sharp instrument, 3; heart transfixed entirely, 1; needle, 1; piece of ramrod, 1; bayonet, 1—the individuals dying at different intervals varying from nine hours to sixty-six days.

Since this " Collection " was made quite a number of cases have been reported by various observers in which life has been prolonged from a few hours to days, weeks, months, and even years. Fischer collected 452 cases of heart-wounds in which death occurred in two or three minutes after the injury in about one-fifth of the cases, and 72 recovered; the diagnosis in 88 verified by subsequent post-mortem, death being from other causes.

Wounds and injuries of the heart produce death by—1, *hemorrhage;* 2, *shock;* 3, *arrest of the heart's action* by the accumulation of blood in the pericardium or around the heart in the thoracic cavity; 4, *by inflammation, suppuration,* or *sequelæ* due to the subsequent progress of the wound, lesions set up thereby, or induced by the character of the injury and the instrument producing it. The danger is greater and more imminent by reason of the character of instrument producing the wound, and stands in the following order : (*a*) contused and lacerated wounds, such as gunshot wounds, those produced by blunt and irregular instruments, etc., and punctured wounds if the instrument is of large size; (*b*) incised wounds; (*c*) punctured wounds made by small instruments. In most instances the hemorrhage in contused and lacerated wounds will be so severe as to cause death almost immediately; and shock, excessive inflammatory, suppurative, and other sequelæ are more certain to supervene. Incised wounds are not always attended by immediate alarming or serious hemorrhage, and shock may be at first slight. A thin, narrow blade transfixing the muscular walls makes a valve-like opening by means of the interlacing muscular fibres; severing some, it passes between others; while shock is also apt to be slight. A greater danger is from the *accumulation of the blood around the heart*, impeding or arresting its action. Punctured wounds are likely to be attended with shock, hemorrhage, and subsequent developments in proportion to the size of the agents by which they are produced.

The evidence of wounds of the heart may be summarized as follows : character, site, course, and nature of instrument producing the wound,

together with certain phenomena referred to the heart itself, as a systolic bellows-sound, a peculiar tremor about the heart, with small, intermittent pulse, an undulating crepitation and bruit, and such phenomena as can be obtained by careful auscultation and percussion. Dulness upon percussion over an increased and increasing area, syncope, precordial anxiety and dyspnœa, diminished impulse of the heart, and pain may be suggestive when present.

TREATMENT.—The patient *should at once be placed in the recumbent position and kept there*, with head low and every possible movement prevented. If he has to be moved, it must be done with the greatest care and caution to prevent any undue movement of the body, and should be preceded by a full dose of morphia hypodermically. Narcosis as deep as may be considered safe should be maintained for some days—at least until all danger from shock and hemorrhage is considered past. Thirst should be prevented so far as possible, and nutrition maintained rather by copious enemata of fluids and semi-fluids than by the mouth, the act of deglutition, even of fluids, having the effect of increasing the heart's action, which is to be avoided as adding to the danger from hemorrhage. Digitalis should not be given, nor stimulants; far better will be found veratrum and other cardiac sedatives : to diminish as much as possible the heart's action is of the greatest importance.

So long as the heart's action seems to be maintained to a reasonable degree, only the simplest antiseptic dressings to the external wound are called for. A flannel bandage applied as tightly as consistent with comfortable respiratory movement should be early applied and maintained in position. Over this an ice-bag or cold applications, rapidly evaporating lotions if the ice-bag seems to disturb the patient by its weight, or cold cloths frequently reapplied. The strictest quiet of surroundings and of the patient's mental condition is imperative.

If life be maintained for twelve to twenty hours or more, and a careful examination, which should be made at frequent intervals without disturbing the patient, shows that the heart's action is becoming impeded by the pressure of extravasated blood around it, manifested by more feeble pulse and heart-sounds, cyanosis, dyspnœa, etc., then comes the propriety of opening the chest and pericardium, removing clots and blood by washing out with warm water thoroughly sterilized or other means. This may be done by simple incision between the fourth and fifth ribs on the left side, if other location is not indicated by the character of the wound, or by excising the cartilages of one or more ribs. An incision a few lines within the border of the sternum parallel with the lower border of the fifth rib or lower, extending outwardly about one and a half or two inches or more, is made ; then a similar one parallel with the upper border of the fourth or third rib, or higher if deemed necessary, connecting the two by a transverse incision about the centre and turning the flaps well back. The costal cartilages, having been separated from the sternum, may be elevated, and the ribs or their cartilages severed at a point distant enough from the sternum to give sufficient room. The internal mammary artery may have to be secured, as well as the intercostals. Pushing the pleura to one side (if this has not been done by the distended pericardium), the pericardium can be opened to such an extent transversely or longitudinally as may be

deemed advisable. Gussenbauer performed this operation satisfactorily for purulent pericarditis after the above method. The site chosen is the one of election.

The following is a brief synopsis of a case reported by H. C. Dalton, M. D., of St. Louis in 1894 : " A man in a fight was stabbed over the left breast ; the wound was an inch in length and an inch and a half above the left nipple. There was little hemorrhage from the wound, and normal cardiac dulness was found on percussion. The percussion of the chest showed absence of dulness. The wound was closed and antiseptic dressings applied. Ten hours after admission to the hospital percussion revealed dulness over the entire left side, and much pain was complained of. The patient was removed to the operating theatre and the dressings taken off, when it was found that blood and air gushed from the wound with each inspiration. An incision was accordingly made, eight inches in length, over and parallel to the fourth rib, and six inches of the rib resected. The intercostal artery having been tied, the pleural cavity was found full of clotted and fluid blood, which with each inspiration poured from the wound with great force. The patient was turned on his left side, and with a long pair of forceps, armed with a sponge, the pleural cavity was cleansed of blood. Subsequently it was discovered that a transverse wound of the pericardium existed to the extent of two inches, and steps were taken to suture the lesion. In carrying out this procedure great difficulty was experienced, owing to the pulsation—at the rate of 140 per minute—of the heart. The pericardium with each pulsation of the heart rose and fell, and, in order to carry into effect that which was being attempted, it was necessary to follow the movements of the organ. Ultimately, a continuous suture of catgut was satisfactorily inserted in the wounded pericardium ; the pleural cavity was then thoroughly irrigated with sterilized warm water, the external wound closed, without a drainage-tube, and antiseptic dressing applied. It may be noted that at several stages of the operation, which lasted an hour, the patient seemed to be dying, and in order to avert collapse hypodermic injections of whiskey and strychnia were resorted to. Before the pericardial wound was sutured, examination of the heart was made with a view to the discovery of a wound in the organ, but no lesion was found. The patient made an uninterrupted recovery."

Thirteen years ago Dr. Block of Strasburg pointed out that death in cases of heart-wounds resulted, as a rule, from hemorrhage, not shock, and that sufficient time was often given for suture, which his experiments on dogs showed was possible. De Vecchio made a similar report at the last International Medical Congress at Rome, 1895.

These are the general outlines suggested ; it may be necessary to vary them in any particular case : First, regard the most imminent danger and ward it off—by passive measures if possible, and, if they seem to be ineffectual, resort to active ones, always keeping within the lines of reason and a correct knowledge of the situation.

Should it become necessary, as I believe it to be possible, to suture a wound in the heart-walls, interrupted sutures closely applied, made of thoroughly aseptic animal tissue, should be used ; so also in closing the wound in the pericardium. While aseptic silk will be encysted,

here we want absorption of the suture, which will not be necessary to remain very long : forty-eight hours will amply suffice for adhesion in so vascular an area. Park has shown the success of this measure in dogs.

PARACENTESIS OF THE HEART, or CARDICENTESIS, may be necessary in cases of engorgement of the right cavities from pulmonary disease where death from dyspnœa is imminent from the overtaxed condition of the heart. While it should never be resorted to so long as other measures hold out any hope, death should at least be held at bay as long as possible by resort to this operation, and a successful issue may result. It is a well-attested fact that the introduction of a small, aseptic aspirator or other needle into and through the heart-walls has produced no material injury of this organ.

Of the two cavities of the right heart, I would prefer the ventricle, by reason of its thicker walls. Introducing the needle into the space just above the fourth rib, about one inch to the right of the sternum, and pushing it backward, inward, and slightly downward, or going in just above the fifth rib and pushing it directly backward and inward, the right ventricle may be reached—the only precautions being that the aspirator be in good working order and the needle thoroughly aseptic, as should be the site of puncture as well as the operator's hands. From three to six or more ounces of blood may be withdrawn as the exigencies of the case may require. Dr. G. C. Cottam of Rock Rapids, Iowa, has reported a case in which he, in his efforts to reach the right auricle through the sixth interspace, tapped the left ventricle : the result was, however, satisfactory, as his patient, who was in an advanced stage of incipient phthisis and at the point of death, lived six weeks longer, and was far more comfortable, death being due to exhaustion.

Dr. Allan D. Sloan has reported a case in which he plunged a trocar attached to an aspirator directly into the right side of the heart, through which some eight ounces of blood flowed. This happened in the case of a woman suffering from pericarditis with effusion. The woman was apparently dead from heart failure, its action having ceased, and a hurried attempt was made to evacuate the fluid with the above result. He supposed when the blood flowed that the woman would die from the heart injuries. However, the cannula was withdrawn a little, the fluid evacuated, and, to the doctor's surprise, the heart began to beat again, and after an hour or two the patient regained consciousness; two months later she was sent to the country, and four months later was reported as being perfectly well. Park has even tapped an abscess in the heart-wall.

Numerous other cases might be cited from the literature of the past, but these, the most recent, are deemed sufficient.

PARACENTESIS OF THE PERICARDIUM is now a well-known procedure, though not so frequently resorted to as it should be, notwithstanding the valuable addition to its literature made by Prof. John B. Roberts, M. D., of Philadelphia, in his most excellent monograph. Paracentesis should unhesitatingly be resorted to whenever life is in danger from distention of the sac by an effusion of any extent, no matter what the amount of the effusion or the cause of the disease may be. Roberts says : " Whenever the effusion, whether it be serum, pus, or blood, accumulates so rapidly or in such quantity that it threatens to destroy life and refuses to undergo absorption by ordinary treatment, it is the duty of the attendant to tap the distended sac." Given an excess of fluid in the pericardium, great or small, and a manifesta-

tion of failure of the vital powers not due to other well-defined causes, indicated by feeble cardiac action, ill-defined and weak heart-sounds, thready and flickering pulse, cyanosis, dyspnœa, orthopnœa, etc., then we do not hesitate to use the aspirator any longer than to take timely and necessary precautions that have already been suggested in tapping the heart—viz. a good working instrument, small needle, and strict asepsis.

The point to be selected is preferably in the fourth or fifth left intercostal space, about two to two and a quarter inches to the left of the median line of the sternum, entering rather nearer to the upper edge of the lower rib bounding the space, pressing the needle backward and slightly inward until the sense of resistance is no longer felt by reason of the needle entering the sac or the fluid appears in the outflow tube. The patient should be as nearly recumbent as possible, to allow the heart to fall back from the anterior wall of the sac. Should the sac refill, it can be again emptied, and in the event that pus, and not serum, in a first or subsequent aspiration appears in the outflow, there is nothing to be done when the sac fills again, as it surely will, but open incision[1] and thorough drainage, as in a case of empyema of the pleura. Care should be taken in the introduction of the needle, and a just estimate made as to the depth at which the heart will be found : this reached and no evidence of having gained access to the sac existing, the needle had better be withdrawn slightly and pushed forward in a little different direction again, or another site tried. If the cartilage is perforated, a disk may

Fig. 52.

Small trocar and cannula—can be used with or without aspirator.

block the lumen of the needle and cause error ; this will not occur, however, if the H. Landis Getz trocar and cannula be used, which are by far the best if those small enough can be secured, as after the trocar is withdrawn a rounded and not a sharp point is left to come in contact with the heart-wall as the effusion escapes. The Fitch dome trocar, if of small size, is also a very suitable instrument, as is the one suggested by Roberts.

If, after the second or third evacuation of a serous exudation, the sac again fill, the injection into the sac of a solution of iodine (tr. iodini, 3 fluid drachms ; potas. iodidi, 20 grains ; aq. dest., 10 fluid drachms) has been proven to be both applicable and successful.

Quite a number of able authorities have advised other points than the one suggested, which is the one preferred by Roberts, and which I deem the most suitable, except in cases in which a bulging of an intercostal space or at some other point may indicate that the fluid can be more easily reached.

Rotch of Harvard University advises the fifth right interspace as being the most accessible, and with less danger of puncturing the over-

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[1] First practised by Romero in 1801, afterward by Rosenstein and others.

lying pleura than the left side. His observations possibly having been made on children, the heart is more likely to be found nearer the central line than in adults. Professor O. H. Wilson, M. D., of Vanderbilt University, however, has reported a successful case of tapping in the position recommended by Rotch in an adult. Ebstein of Göttingen also reports a similar case.

In purulent pericarditis, which cannot be definitely diagnosed until the character of the fluid is open to ocular inspection, there is only one course of procedure. It has been thought that a purulent effusion would be indicated by a greater degree of severity in the clinical phenomena, greater depression, a lower state of health, more feeble cardiac and pulse movement, etc. But there is no satisfactory and reliable evidence other than the fluid itself: this may be obtained by a long needle attached to an ordinary hypodermic syringe. When we are satisfied that there is pus within the pericardium, it should be thoroughly evacuated by a free incision, a drainage-tube inserted, and, if thought necessary, the cavity washed out with a warm (100° to 105° F.) mild antiseptic solution. Or it may be well enough, in order to secure thorough drainage, to remove a section of one or more ribs, which will be advisable in some cases.

A case reported recently by Eiselberg in *Wiener klin. Woch.* is of special importance, it being that of a boy of seventeen who developed purulent pericarditis after a stab wound of the pericardium. Puncture of the pericardium having been performed several times without relief, incision was determined on. The cartilage of the fourth rib on the left was resected, and the thickened pericardium exposed. After exploratory puncture it was opened by a transverse incision 4 cm. in length, and 2 litres of sero-purulent fluid were evacuated. The cavity was washed out with warm water, salicylated, the borders of the pericardial incision stitched to those of the wound, and two drainage-tubes inserted. Complete recovery took place in four weeks. Eiselsberg insists upon the importance of suturing the pericardium to the lips of the wound to prevent infection of the pleura.

In cases of hydropericardium due to renal disease or other cause than pericarditis I would prefer an open incision and drainage rather than repeated tapping.

LIGATION OF ARTERIES.

The ligation of arteries is resorted to for the control of hemorrhage, the cure of aneurisms, the arrest of the growth of inoperable tumors, and the relief of hospital gangrene. While the necessities of the case may require any point to be selected, the operations here given are at the site of election, and may have to be materially modified to meet the exigencies of the occasion. The essentials are a correct knowledge of the anatomy of the part and the principles of modern or aseptic surgery.

It is not essential in all cases, as was taught by Celsus and others in his day, to use two ligatures, dividing the vessel between them, one ligature usually sufficing, leaving the artery undivided, as in the event of secondary hemorrhage at the site of the operation the vessel will again be more readily found. Nor is it necessary in using the aseptic ligature to tie the artery so tight as to divide the internal and middle coats, but only to press the opposing surfaces together temporarily to secure obliteration of its canal. The intima becomes covered with

granulations, developed from it and the clot that forms at the point of arrest of the circulation, which, uniting, form a firm union ; also plastic matter forms around the ligature, absorbing it if of animal tissue or encysting it if of aseptic silk, the exudate strengthening the vessel at the point of ligation. If an artery be divided and its extremity is to be secured, the knot should be sufficiently tight to prevent its slipping off.

The ligature should be of perfectly aseptic silk, proportionate in size to the vessel to be secured, which I prefer to silkworm gut, catgut, or other animal membrane. Silk can be thoroughly sterilized by boiling, and is much safer and more reliable.

The instruments necessary are a scalpel, two pairs of dissecting-forceps, wound-hooks, retractors, rat-toothed forceps, pressure-forceps, aneurism-needles, ligatures, and aseptic absorbent cotton to use for sponging ; a head-mirror will be found useful for illuminating a deep incision. In securing the deeper-seated arteries, as the iliacs, broad metal spatulæ and large rectangular retractors will be of use.

The position of the patient will vary a little according to the artery to be secured. In general, the surgeon should stand on the side to be operated on, making the incision from above downward on the right and from below upward on the left side.

The line of the artery must be well located, which may vary from what is usually given as the anatomical line of the vessel, and a special position of the part is essential, varying with the portion of the artery and the vessel to be secured ; also, the operator should be well aware of possible anomalies of position, congenital or the result of previous wounds and operations.

The scalpel should be held in what is known as the dinner-knife position, and a clean, free incision made through the integument over the course of the vessel, the knife entering at right angles to the surface, retaining this position when withdrawn, so that the wound should be of equal depth throughout. The length of the incision will depend entirely on the vessel to be secured, but had better be several lines too long than one line too short, so that free access to the vessel can be had. The skin should be steadied with the fingers of the left hand while it is divided. The superficial fascia, having been divided, brings us to the deep fascia, beneath which the underlying muscles and tendons are more or less distinct. The separation between two muscles has usually to be followed, and in ordinary fleshy cases will be indicated by a white or yellowish line, but this is not so apparent in emaciated persons. The deep fascia having been divided with the finger-nail or the handle of the scalpel—its cutting edge should not be used here—we endeavor to work down between the muscles until the artery is reached, the pulsations generally being a sufficient guide to the educated finger. If the limb was extended when the first incisions were made, it may now be slightly flexed, so as to relax the muscles and afford easier access to the artery.

With retractors in the hands of an intelligent assistant, firmly held, and careful sponging of the wound with aseptic gauze or cotton, all bleeding branches either having been secured by ligature, torsion, or temporarily by catch-forceps, the sheath of the vessel is brought into

view. Superficial veins that may be made apparent by pressure and nerve-trunks or branches must be carefully avoided or pushed to one side.

The artery when reached will be apparent to the sense of touch. When held between the finger and thumb it can be compressed and its pulsations will be apparent; it is less easily compressed than a vein, which swells out below on pressure, and scarcely feels like a tube, while the nerve cannot be flattened by pressure, and is firm, resisting, round, and cord-like. If an aneurism exists beyond the site of operation, pulsation in it will cease on compressing the artery.

It next remains to open the sheath and clear a part of the vessel for the passage of the aneurism-needle. The sheath is picked up with a pair of rat-toothed forceps, grasping it in a transverse position or at right angles to the course of the vessel, held firmly and well up from the artery, and a clean incision from one-quarter to one-half an inch made in it parallel with the direction of the artery; the blade of the scalpel should be inclined obliquely, with the flat of the knife toward the artery.

Retaining hold on the sheath by means of the forceps in the left hand, the scalpel is exchanged for the aneurism-needle, which should be gently insinuated halfway around the artery within the sheath, entering on the side of the incision held by the forceps, which are now detached, and the sheath on the other side of the incision is grasped and held up; moving the point of the needle slightly from side to side, it is gently insinuated entirely around the vessel until the eye emerges from the opening in the sheath. The ligature is then inserted in the eye of the needle, which is withdrawn, bringing the ligature with it. Care must be taken not to include a vein in the ligature, and more especially the trunk of a nerve, which can be ascertained by making careful traction on both ends, slightly lifting the artery.

The needle should be kept throughout at right angles to the artery, and should never be threaded until it has passed around the vessel. The ligature should be passed and tied also at right angles to the artery with a " reef-knot," unless there are special indications for the use of the " surgeon's knot."

The points of the two fore fingers, with the ends of the ligature in the hand passing over them, should meet upon the artery as the knot is being tightened, and care should be taken that the artery is not dragged out of its place. The knot should be tied gently, slowly, and firmly, avoiding anything like a jerk.

The wound is closed by superficial and deep sutures if the latter are considered necessary, well dusted with iodoform, and the limb bandaged. If the main artery of a limb is ligated, it should be slightly elevated, kept sufficiently warm by artificial heat, bottles of hot water, etc. if necessary, and absolute rest maintained for two or three weeks longer— in case of the subclavian, iliac, or common femoral absolute rest is imperative for at least three weeks.

Ligature of the Innominate Artery.—The patient lies upon the back close to the edge of the table, chest raised, and head extended and turned to the left, with the arm pulled down and securely fixed. The surgeon stands on the right side and in front of the shoulder. A good light is

essential, and means should be at hand for getting it well down into the depths of the wound.

Along the upper border of the inner third of the clavicle the first incision is made about three inches in length, which is joined by one of the same length along the anterior edge of the sterno-mastoid muscle, the two joining at an acute angle. The skin and superficial fascia having been divided, the flap is dissected up. The sterno-hyoid and sterno-thyroid muscles, with a few fibres of the sterno-mastoid, are separated from the sternum, care being taken of the anterior jugular vein as it passes behind the last-named muscle at its origin, which may have to be divided ; if so, it should be secured by two small ligatures and divided between them. The deep cervical fascia is now exposed and divided in the line of the external wound, and the common carotid artery sought for, its sheath opened as low down as possible, and this artery followed until its junction with the subclavian is reached.

According to Jacobson, the engorgement of the venous circulation, increased by the anæsthetic, will cause the internal jugular and the innominate veins to protrude through the wound. The artery may be flattened out by an aneurism, making it difficult of recognition ; and the cellular tissue around the vessel and between it and the sternum may be so matted with adhesions as to make it difficult to define the artery and its important surroundings—viz. the par vagum, pleura, and innominate vein. The artery must be cleared with the utmost caution, especially on the outer side ; the par vagum and innominate vein may be drawn to the outside. The aneurism-needle should be passed from without in, and a little from below upward, so as to avoid the pleura as much as possible. Several aneurism-needles with different curves should be at hand, and a laryngeal mirror will be a valuable aid.

Ligature of the Common Carotid below the Omo-hyoid Muscle. —The patient is placed as in the former operation, the head turned slightly to the opposite side, and the hand of the affected side placed behind the back. An incision is made about three inches in length over the course of the artery, commencing a little below the cricoid cartilage and extending to just above the sterno-clavicular articulation, following the inner border of the sterno-mastoid muscle, which is exposed and drawn outward ; the sterno-hyoid and sterno-thyroid are drawn to the inner side ; the omo-hyoid, if brought into view, is pushed upward. The communicating vein from the facial to the anterior jugular and the latter vein must be avoided, and the inferior thyroid veins may give some trouble. Retractors are needed and a good light is essential. The sheath is opened on the inner side, and care must be taken to avoid the descendens noni nerve. The needle is passed from within outward. On the left side the internal jugular vein may complicate the operation.

Ligature above the Omo-hyoid Muscle.—Position of the patient same as in the preceding operation. Incision, about three inches in length, with its centre level with the cricoid cartilage, is made over the course of the artery. The skin and platysma having been cut through (together with branches of the superior cervical nerve), the deep fascia along the anterior border of the sterno-mastoid is cut through. The edge of this muscle having been made out, it must be followed down until the omo-hyoid is reached. The communicating vein from the

facial and the anterior jugular must be avoided. The sterno-mastoid may be drawn a little outward and the omo-hyoid downward, and the angle between the two muscles well cleared. The pulsations of the artery should now be sought, and the vessel can be readily detected as it crosses the " carotid tubercle." The carotid tubercle is the anterior projection of the transverse process of the sixth cervical vertebra, and

FIG. 53.
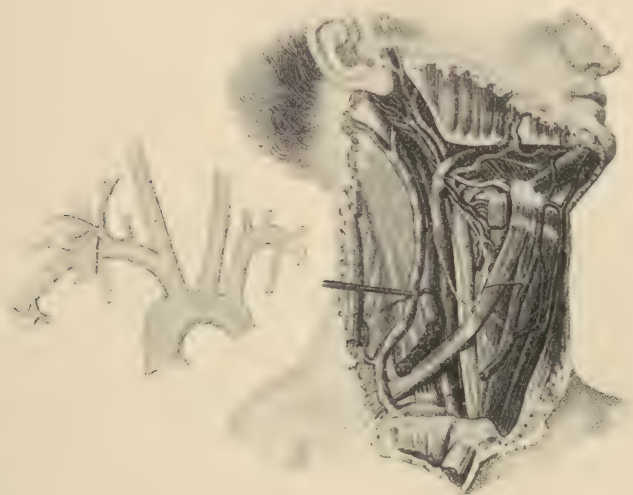
FIG. 54.

Surgical anatomy of the neck; ligation of the carotid, lingual, and facial arteries (Bernard and Huette).

is about two inches above the clavicle. The sterno-mastoid artery and the superior and middle thyroid veins must be avoided, and care taken of the descendens noni nerve. The needle is passed from without inward.

Ligature of the External Carotid.—Position of the patient same as in the preceding operations. An incision from near the angle of the

jaw, along the line of the artery, is made, terminating about even with the middle of the thyroid cartilage. The greater cornu of the hyoid bone will be about the centre of the incision. The integument and platysma having been divided and superficial veins secured, the fascia is next divided, and the anterior border of the sterno-mastoid exposed at the lower part of the incision, which must be drawn outward. The posterior belly of the digastric is next cleared at the upper angle of the wound, and the hypoglossal nerve below it exposed, being careful not to injure it. With the finger the great cornu of the hyoid must now be sought, and the artery will be found and can be readily exposed opposite its tip, and can be ligated between the superior thyroid and lingual arteries, or below the latter if necessary. The facial and superior thyroid veins must be avoided, and lymphatic glands may lie in front of the artery. The artery having been cleared, the needle is passed from within outward, taking care not to include the superior laryngeal nerve, which passes down behind the artery.

If it is desired to ligate above the digastric muscle, or the operation " behind the ramus of the jaw," the method is thus given by Jacobson : The head and shoulders being duly raised and supported, the surgeon makes an incision downward from the tragus of the ear just behind the ramus of the jaw, dividing skin and fascia. The sterno-mastoid must now be drawn outward and the digastric and stylo-hyoid downward ; and it will probably be needful to divide these muscles partially in order to secure the artery before it enters the parotid gland, which must be drawn upward and forward. The needle may be passed from either side. " This operation," says Jacobson, " has the disadvantage of probably entailing division of important branches of the facial nerve."

Wyeth says : " The common carotid should never be tied for a lesion of the external carotid or its branches when there is room between the lesion and the division of the common carotid to permit the ligature of the external vessel " (Figs. 53 and 54).

Ligature of the superior thyroid artery is in all essential particulars similar to that of the external carotid below the digastric muscle, the needle being passed from above downward, care being taken to avoid the superior laryngeal nerve. The plexus formed by the thyroid veins may give trouble.

Ligature of the Lingual Artery at its First Part.—Position of patient same as in operation on the common carotid ; incision similar, though shorter, with its centre opposite the body of the hyoid bone. The external carotid is sought for, and carefully followed until the lingual is reached. The wound will be deep, and the first portion of the vessel more or less obscured by numerous veins (Figs. 53 and 54).

Ligature at the point of election or beneath the hyo-glossus muscle is thus described by Treves : " The patient lies close to the edge of the table, with the shoulders raised and the face turned to the opposite side, with the arm of the affected side placed behind the back. An assistant must keep the chin well drawn upward and the lower jaw fixed. The surgeon stands on the side to be operated on. The chief assistant is placed opposite to him, and leans over the patient's body. A second assistant stands by the surgeon's side. His chief duty is to hold the hook which commands the digastric tendon. Full anæsthesia and the skin of the submaxillary region in the male shaved. An incision some

two inches in length, curved and with the convexity downward, is made between the lower jaw and hyoid bone, commencing a little below and to the outer side of the symphysis, and ending a little below and to the inner side of the point where the facial artery crosses the lower margin of the maxilla. Its centre is just above the greater cornu of the hyoid bone. On the right side the incision is made from behind forward, and on the opposite side from before backward. The integument, platysma, and superficial fascia are divided in the line of the incision. Certain superficial veins will be encountered, and some will probably have to be secured. These are the submental or other tributary veins of the facial, or some tributary of the anterior jugular. It will now be convenient to resort to retractors in order that the depths of the wound may be well laid open. The next step is to expose the sub-maxillary gland, lodged in a special compartment of the cervical fascia, which should be opened transversely over the lower part of the gland, the organ cleared and brought well out into the wound by means of the finger and the handle of the scalpel. The gland should be turned upward on to the margin of the jaw, and kept well out of the field by a broad and well-curved retractor held by the chief assistant. The fascia exposed by lifting out the salivary gland is now to be divided transversely, and in the anterior angle of the wound the posterior edge of the mylo-hyoid muscle must be sought for and defined. The digastric tendon and the two bellies of the muscle are now to be brought clearly into view. Around the tendon, which is nearest to the hyoid bone, a small blunt hook, with a very long shaft or handle, is to be passed and held by the assistant who stands at the surgeon's side. The tendon should be drawn downward and toward the surface. The hyo-glossus muscle can now be easily made out, and its exposed surface freed of connective tissue. The hypo-glossal nerve must be sought for as it crosses the muscle, and the surgeon's work limited to the segment of muscle below the nerve. Crossing the hyo-glossus below the nerve, and parallel with it, is the ranine vein. This vein will about correspond in position with the artery, which lies beneath the muscle. The vein and nerve should be displaced upward. The hyo-glossus muscle is divided transversely, to the extent of half an inch, a little above the margin of the hyoid bone and parallel with it. The incision in the muscular tissue must be cautiously deepened. If the cut has been well placed, the artery will bend out into the wound and make itself evident as soon as the whole thickness of the muscle has been divided. The needle, unthreaded, is most conveniently passed from above downward. In the ligature the minute venæ comites which attend the artery are no doubt included."

Ligature of the facial artery may be placed by an incision similar to that exposing the external carotid or the first part of the lingual. It is more conveniently secured as it crosses the margin of the lower jaw. A horizontal incision is made over the course of the artery, along and just under the inferior margin of the jaw, one inch in length, where we find the artery crossing the bone at the anterior border of the masseter muscle. It is only necessary to divide the skin, platysma, and fascia. The facial vein is behind the artery and very close to it. The needle should be passed from behind forward (Figs. 53 and 54).

Ligature of the temporal artery is applied by an incision, one inch long vertically, over the course of the artery, between the tragus and condyle of the lower jaw. It is only covered by skin and dense fascia, a single large vein lying behind and overlapping it. Temporo-facial branches of the facial nerve cross the artery, which lies behind the auriculo-temporal nerve. The ligature should be passed from behind forward.

Ligature of the occipital artery may be applied close to its origin and also back of the mastoid process. In the first position an incision similar to that exposing the external carotid at its upper part will suffice. In the second position an incision nearly horizontal, two inches long, is made, commencing at the tip of the mastoid process and carried backward and a little upward. The skin and fascia having been divided, the posterior fibres of the sterno-mastoid are cut; next the splenius is divided, and so much of the trachelo-mastoid as many be necessary. The artery is then felt and exposed in the interval between the mastoid process and the transverse process of the atlas, which can be felt with the finger. The needle can be passed either from above or below.

Ligature of the Internal Carotid.—Position of the patient and operator same as in operation on the external carotid at its lower point, and the incision is also almost similar, being a little more to the outside. The anterior edge of the sterno-mastoid is exposed and drawn outward. The external carotid is found and followed down to its junction with the internal, and drawn gently inward with a blunt hook. The digastric muscle is drawn upward. The sheath of the vessels is opened with care, and the needle passed from without inward, observing the same care as in ligating the common trunk. The internal jugular vein, the par vagum, the sympathetic ganglion, and the ascending pharyngeal artery, all lying close to the artery at this point, must be avoided. The internal differs from the external in giving off no branches in this part of its course (Figs. 53 and 54).

Ligature of the Vertebral Artery.—Position of the patient same as in ligation of the external carotid. An incision commencing at the clavicle is carried up along the outer edge of the sterno-mastoid muscle for three inches, dividing the skin and superficial fascia; a few fibres of the attachment of the sterno-mastoid must be severed close to the clavicle. The deep fascia having been severed, the sterno-mastoid muscle and anterior jugular veins are drawn inward. The scalenus anticus muscle is next found, and the interval between it and the longus colli muscle entered with the finger, the position of the common carotid and internal jugular vein made out, and the transverse processes of the sixth and seventh cervical vertebræ located; below that of the former the artery should be felt. The various structures must be pushed to one or the other side. The vertebral vein lies in front. Care must be taken not to damage the inferior vessels, the pleura, or the thoracic duct on the left side. The needle is passed from without inward.

Ligature of the Inferior Thyroid Artery.—An incision three inches in length along the inner edge of the sterno-mastoid muscle, as in ligation of the common carotid, low down, the wound reaching down to the clavicle. The sterno-mastoid is drawn outward, and the carotid artery and its vein are also drawn gently outward. The transverse

process of the sixth cervical vertebra is now carefully sought, a little below which the artery may be found, passing inward behind the carotid, close to which vessel the ligature is applied, thus avoiding the recurrent laryngeal nerve.

Ligature of the Subclavian Artery.—While the ligature has been applied to the first and second portions of the subclavian, it is now

Fig. 55.

Fig. 56.

Surgical anatomy and ligation of the axillary and subclavian arteries (Bernard and Huette).

almost exclusively limited to the third part, which comprises that segment of the vessel crossing the posterior triangle of the neck and where it is most superficial. The base of this triangle is formed by the outer edge of the scalenus anticus muscle and the sides by the omo-hyoid muscle and the clavicle, the latter muscle being about one inch above the bone (Figs. 55 and 56).

The artery here is covered by skin and the platysma, the cervical fascia, and a fibrous expansion extending from the omo-hyoid muscle to the clavicle, and rests upon the first rib, with the scalenus muscle behind and cords of the brachial plexus of nerves above, that one derived from the eighth cervical and first dorsal nerve being nearest the artery. The subclavian vein is below and anterior to the artery, passing in front of the scalenus anticus.

The external jugular vein is usually in front of the artery, though its position may vary : the transverse cervical and suprascapular veins, entering it here, may form a plexus over the artery.

The suprascapular artery lies behind, covered with the clavicle, and the transverse cervical artery crosses beneath the omo-hyoid muscle at some distance above the main vessel. Normally, there is no branch given off from the subclavian at this part. In ligating the subclavian in the third part of its course the patient lies on the back, near the edge of the table, with thorax raised and head extended and turned to the opposite side, the arm pulled well down, passed behind the back, and securely fixed. The operator stands in front of the shoulder, a good light being essential.

Drawing the skin over the posterior triangle well down with the left hand, an incision is made through it, reaching the clavicle. The incision, parallel with the clavicle, should be about three inches in length, and when the downward traction of the skin is withdrawn should be about one inch above the clavicle, extending across the base of the posterior triangle from the trapezius to the sterno-mastoid, with the centre of the wound even with a point about one inch to the inner side of the centre of the clavicle. The integument, the platysma, and supraclavicular nerves, with, possibly, a vein passing over the clavicle connecting the cephalic vein with the internal jugular, are divided by the incision. The amount of the trapezius and sterno-mastoid exposed will depend upon the extent to which they are attached to the clavicle (Figs. 55 and 56).

The deep cervical fascia is next divided the extent of the primary incision, carefully and without the aid of a grooved director. If the external jugular vein cannot be drawn to one side with a blunt hook, it should be divided between two ligatures and all bleeding vessels secured.

The outer margin of the scalenus anticus should next be made clear, and the position of the omo-hyoid developed, and if at all in the way it must be drawn upward. The finger should be passed along the edge of the scalene muscle until the tubercle of the first rib is reached, when it will be in contact with the artery and its pulsations felt, the vessel resting on the rib. A little careful dissection will clear the artery and bring into view the lowest cord of the brachial plexus, which should be systematically exposed by a slight but careful dissection. The subclavian vein will be seen and felt, but it does not encroach upon the field of operation. The needle may now be carefully passed from above downward and from behind forward, its course guided by the fore finger of the left hand, protecting and holding the vein out of the way.

In some cases portions of the trapezius and sterno-mastoid may have to be cut. The transverse cervical or suprascapular arteries may be in

the way, and must be drawn aside, and in no instance cut, as they perform an important part in the collateral circulation.

If the patient is stout with short neck, the difficulties will be enhanced. A plexiform arrangement of the veins, their engorgement, matting together and œdematous condition of the tissues greatly increase

Fig. 57.

Fig. 58.

Surgical anatomy of the axilla and ligation of the axillary artery (Bernard and Huette).

the difficulties. The pleura must be carefully avoided in passing the needle, as well as the lower cord of the brachial plexus.

Ligature of the axillary artery is practically limited to its third part. The course of the artery will be covered by a line from the centre of the clavicle to the humerus, close to the border of the coraco-

brachialis muscle, when the arm is so abducted as to be at right angles to the body (Figs. 55–58).

The patient is placed upon the back, close to the edge of the table, with the shoulders raised, the arm at right angles to the body and held horizontally, the surgeon placing himself between the arm and the thorax.

The axilla having been shaved, an incision about three inches in length is made along the course of the artery, commencing at the middle of the outlet of the axilla, at the junction of the anterior and middle thirds, and continued downward along the inner margin of the coraco-brachialis muscle. The knife should be held with the blade horizontal, and the coraco-brachialis thoroughly exposed after skin and fascia have been divided. This muscle, with the musculo-cutaneous nerve, is gently drawn outward, when the position of the artery may be determined with the finger. In clearing the artery the median nerve is exposed, and should be drawn outward with a blunt hook, and the internal cutaneous nerve pushed to the inner side. The venæ comites having been well demonstrated, the needle is passed from within outward.

Ligature of the Brachial Artery at the Middle of the Arm.—The limb should be extended and abducted, with the hand supine and held away from the body, the arm itself unsupported, but the limb held securely by an assistant grasping the forearm. The surgeon stands on the outside of the limb on the right side and between the body and the limb on the left, making his incision from above downward. The incision, about two and a half inches in length, should be made along the inner edge of the biceps muscle in the line of the artery. The fascia, which is here thin, is exposed and divided, and, the muscular layer reached, the inner edge of the biceps clearly exposed and defined. The muscle is displaced slightly outward, and the pulsation of the vessel sought. If the median nerve is not brought into view, a little dissection will clear it : in the middle of the arm it usually lies in front of the artery, and should be displaced gently to the outside : below the middle of the arm it is more conveniently displaced inward. While the artery is being exposed the elbow may be slightly and moderately flexed (Figs. 59 and 60).

The sheath of the vessel having been opened, the venæ comites separated as well as possible, the inner one usually being the larger, the needle is passed from the median nerve.

In the upper part of its course the inner margin of the coraco-brachialis is exposed instead of the biceps, and the ulnar nerve will be found lying to the inner side of the vessel.

Ligature of the Brachial Artery at the Bend of the Elbow.—The limb, extended and abducted, may be allowed to rest on the olecranon. It should never be over-extended. An incision, two inches in length, with its middle in the centre of the "fold of the elbow," is made through the skin along the inner edge of the biceps and parallel with its margin. The upper end of the incision will be on a level with the tip of the internal condyle, and will extend obliquely downward and toward the centre of the arm (Figs. 59 and 60).

If the veins are normally placed, the incision will lie to the outer side of the median basilic and nearly parallel with it. As soon as the vein is exposed it should be drawn inward, and the bicipital fascia

divided in the line of the original incision. Its fibres will be found extending obliquely downward and inward. The artery, with its venæ comites, being now exposed, the veins are separated and the needle passed from within outward. The vessel here is quite movable and free from attachments. The median nerve is not exposed, and is nearest the artery (on its inner side) at the upper part of the wound.

Ligature of the radial artery may be applied at the upper, middle,

FIG. 59.   FIG. 60.
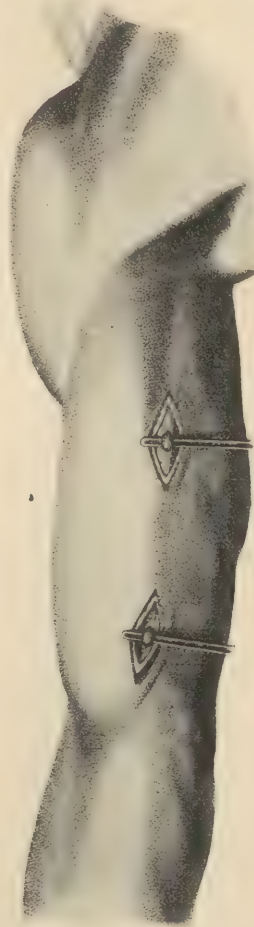
Surgical anatomy and ligation of the brachial artery (Bernard and Huette).

and lower third of its course. The radial continues the line of the brachial, and a line extending from the middle of the bend of the elbow to the gap between the scaphoid bone and the extensor ossis pollicis and extensor internodii pollicis will give its position reasonably definite.

In the upper third of the forearm an incision two and a half inches in length is made in the line of the artery. The radial or other surface vein may be encountered. After the deep fascia is divided the interval

between the supinator longus and pronator teres is opened up, the fibres of the supinator being vertical and those of the pronator oblique. Beneath the supinator the vessel will be found unaccompanied by the nerve. The needle can be passed from either side. The limb is supinated, and firmly held by an assistant grasping the hand and arm. The surgeon stands on the side to be operated on (Figs. 61 and 62).

In the middle third, the limb placed as above, an incision two inches in length is made along the course of the artery, any superficial veins from the median or radial being avoided. The anterior division of the musculo-cutaneous nerve lies usually in the line of the artery between the superficial and deep fascia, and must be held aside. The fibres of the superficial fascia run longitudinally, and those of the deep fascia transverse. The deep fascia, being made clear, is divided the length of the superficial incision, and the supinator longus is exposed about the point where it becomes tendinous. The ulnar border of this muscle is defined and drawn outward ; the elbow being slightly flexed will allow this to be done more easily, and the vessel will be found lying upon the insertion of the pronator radii teres, with which it is connected by considerable connective tissue. The nerve may or may not be seen. The venæ comites being separated as well as possible, the needle is passed from either side.

In the lower third, with position as before, an incision one and a quarter inches long is made over the line of the artery at the point where the pulse is usually felt, parallel with and between the supinator longus and flexor carpi radialis muscles, but must not extend below the tuberosity of the scaphoid (Figs. 61 and 62).

The commencement of the radial vein lies over the artery and must be avoided. The fascia, which is here quite thin, is divided in the course of the superficial incision, and the gap between the two tendons made out. The terminal part of the anterior division of the external cutaneous nerve is over the artery and in close relation. If it is found impossible to separate the venæ comites sufficiently to let the needle pass, they may be included in the ligature.

Ligature of the Ulnar Artery.—This vessel, larger than the radial, follows a curved course in the upper third of the limb, and perfectly straight the remaining two-thirds. It lies too deeply for ligature in the upper third, except for arrest of hemorrhage when cut or divided, and the operation of election is left for the middle and lower third. It may be ligated, however, close to the origin of the brachial, if needed, by slightly extending downward the incision for ligating this vessel at the end of the elbow (Figs. 61 and 62).

The artery in the lower two-thirds of its course will be found beneath a line drawn from the tip of the internal condyle of the humerus to the radial side of the pisiform bone.

In applying a ligature in the middle third the position is the same as in ligation of the radial. An incision two and a half to three inches in length, according to the size of the limb, is made over the line of the artery. Branches of the anterior division of the internal cutaneous nerve and the ulnar vein are apt to be encountered.

The deep fascia is thin, and is to be divided the length of, but a little to the outside of, the incision in the skin. The gap between the flexor

carpi ulnaris and the flexor sublimis digitorum is now to be made out by the sense of touch communicated to the fore finger. As soon as the intermuscular space is detected the wrist should be slightly flexed to relax the muscles, and with broad retractors the flexor carpi ulnaris is drawn inward and the flexor sublimis digitorum slightly outward, and the intermuscular space opened up, at the bottom of which will probably

Fig. 61. Fig. 62.

Surgical anatomy and ligation of the radial and ulnar vessels (Bernard and Huette).

be found the ulnar nerve, to the outer side of which is the artery. The fascia binding the vessels is slight, and the venæ comites are readily separated. The needle should be passed from within outward to avoid the nerve. The interspace between the two muscles is not exactly vertical with the limb in position for the operation, the flexor carpi ulnaris slightly overlapping the flexor sublimis, and the interspace is to be

followed down in a direction slanting toward the outer side of the ulna. In very muscular subjects the incision must be made sufficiently long.

In the lower third, the arm being in the same position, a ligature is applied by means of an incision two inches long over the line of the artery, just to the radial side of the tendon of the flexor carpi ulnaris, terminating an inch or less above the pisiform bone. Care must be taken to avoid tributaries of the ulnar vein which may overlie the artery. The deep fascia, here quite slender, is exposed and divided, and the tendon of the flexor carpi ulnaris made out and drawn gently inward by a blunt hook, the wrist being slightly flexed. The vessel will now be found bound down to the flexor profundus by a distinct layer of fascia, which must be carefully divided. The nerve is close to the artery on its inner side. It may be necessary to include the venæ comites in the ligature, which is passed from within outward. The palmer cutaneous nerve lies upon the artery in this location and must be avoided. The tendon of the flexor carpi ulnaris has muscular fibres entering it on the radial side down to the wrist—on the ulnar side it is quite clear (Figs. 61 and 62).

Ligation of the palmar arch and branches of it and the radial or ulnar arteries is only required for traumatisms, the nature of which will determine the method of application.

Ligation of the Abdominal Aorta.—The eleven cases of ligation of the abdominal aorta having all terminated fatally, it is, in my opinion, an unjustifiable operation, affording neither hope to the patient nor éclat to the surgeon; consequently it is only mentioned to be condemned.

Ligation of the common iliac artery can be performed by an anterior or lateral incision or by the intraperitoneal method : the latter is considered by Treves as the best, though it has not yet been satisfactorily tested. It can be carried out by the intraperitoneal method of reaching the internal iliac, to be subsequently considered.

In the anterior incision the bowels should be thoroughly evacuated, any gaseous distention relieved if possible, and the pubes well shaved. The patient lies on the back, with thighs well extended and close together, with the head and shoulders slightly raised to relax the abdominal parietes. The surgeon stands on the side to be operated on, facing the patient, cutting from above downward on the right and in an opposite method on the left. An assistant, to whom is entrusted the care of the broad retractor to be used, stands on the opposite side.

An incision five inches in length is made, commencing one and one-fourth inches to the outer side of the spine of the pubes, a little above Poupart's ligament, the first inch and a half being made parallel with the ligament, when the incision is curved slowly upward, perpendicular to the ligament, terminating about one and a quarter inches to the outside of the umbilicus. The three abdominal muscles and the transversalis fascia are divided carefully ; the peritoneum is carefully and gently stripped from the iliac fossa with the fingers, pushed inward, and held out of the way with a broad retractor : the patient may be turned to the opposite side to aid in keeping the intestines out of the way. A strong needle, of good length, with lateral curve, will be found most available, which should be passed from within outward. The vein lies directly behind on the right, and to the inner side and slightly behind

on the left. Great care must be taken to avoid injury to the perito-neum.

Ligature of the internal iliac artery is accomplished by the extra-or intraperitoneal method. The extraperitoneal method is identical with the anterior operation on the common iliac previously described. The peritoneum having been pushed aside until the external iliac is reached, this vessel is followed down to its junction with the internal. The wound is deep, and several varieties of needles with different curves should be at hand, and on either artery the needle should be passed from within out.

By the intraperitoneal method the abdomen is opened in the median line by an incision extending from symphysis to umbilicus, or a little above in fleshy subjects. The intestines having been pushed up and drawn aside, the area of the deep wound is surrounded by aseptic gauze mats, preferable to flat sponges, and so cut off from the peritoneal cavity. The wound being held well open by broad retractors or spatulæ, the peritoneum over the artery is divided to the extent of an inch and a half, and the common artery followed down to its bifurcation. The vein is much larger than the artery, and the separation will require care. The ureter must not be injured or included in the ligature, and sympa-thetic nerve-fibres must be avoided.

Ligature of the Sciatic or Internal Pudic Arteries.—The patient, having been anæsthetized, is rolled over on to the face, the limb drawn over the edge of the table, and the thigh rotated in. A line drawn from the posterior iliac spine to the outer part of the tuberosity of the ischium, at the junction of its middle with its lower third, will cover the point of emergence of these arteries from the pelvis. An incision four inches in length is made obliquely across this line in the direction of the fibres of the gluteus maximus, its centre corresponding to the point above mentioned. The gluteus maximus is divided in the line of the wound, and the lower margin of the pyriformis muscle and the spine of the ischium well defined. The arteries will be found in front of the pyri-formis muscle : near its lower margin the sciatic is superficial to the pudic, and passes behind it to gain the outer side. Venæ comites accompany both vessels. To the inner side of the pudic at this point lie the internal pudic nerve and its inferior hemorrhoidal branch. The sciatic here is superficial to both the great and small sciatic nerves. The ligature should be placed as near the pelvis as possible.

Ligature of the Gluteal Artery.—Position as in the preceding ope-ration. With the thigh rotated in, a point at the junction of the upper with the middle third of a line drawn from the posterior iliac spine to the top of the great trochanter will overlie the gluteal artery as it emerges from the sciatic notch. An incision five inches in length, with the centre over the above-mentioned point, is made along this line. The incision runs parallel with the fibres of the gluteus maximus, which are separated the thickness of the muscle. A muscular branch may be met with which will serve as a guide to the trunk. The deep fascia between the glutei is divided, and the contiguous borders of the gluteus medius and pyriformis cleared, and the two muscles separated and held apart with retractors. The superficial division of the artery passes between these two muscles, and is followed down to the main trunk. Care must

be taken to avoid the vein and nerve, and the ligature should be placed as far within the notch as possible, almost within the pelvis, as the artery divides soon after emerging therefrom. Some fibres of the great sacro-sciatic ligament may have to be divided.

Ligature of the External Iliac Artery.—The modified form of Sir

FIG. 63.

FIG. 64.
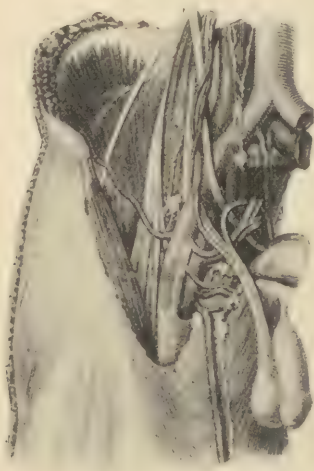
FIG. 65.

Surgical anatomy and ligation of the femoral, external iliac, and epigastric arteries (Bernard and Huette).

Astley Cooper's operation is as follows: The patient lying on the back, head and shoulders slightly raised, an incision is made three and a half inches long above Poupart's ligament. The incision, slightly curved, beginning one and a quarter inches outside the pubic spine, runs for two-thirds of its course about three-eighths of an inch above the ligament and parallel with it, the outer third curving slightly away from

the ligament. The skin and superficial tissues having been cut through and the divided superficial epigastric artery secured by ligature, torsion, or pressure-forceps, the white, glistening aponeurosis of the external oblique now brought into view is divided in the line of the primary incision, following very nearly the direction of its fibres. The parts being retracted, the outer border of the conjoined tendon is made out at the inner angle of the wound. The lower fibres of the internal oblique are divided close to their attachment to Poupart's ligament as far as necessary. The transversalis muscle is attached only to the outer third of the ligament (Figs. 63–65).

The transversalis fascia, being exposed, is divided transversely over the artery and as far on either side as necessary. The deep epigastric artery lying between this fascia and the peritoneum must be avoided.

The external iliac artery now being made out, the subperitoneal tissue about the vessels should be carefully loosened, and the peritoneum pulled from the artery and vein with the utmost care and pushed upward toward the umbilicus, and held out of the way with a broad retractor. The loose subperitoneal tissue, which forms a kind of sheath for the artery, should be cautiously cleared away and the needle passed from within outward. In closing the wound the divided fibres of the internal oblique may be attached to Poupart's ligament, and the aponeurosis of the external oblique united by a few catgut sutures.

Abernethy's operation is described in South's *Chelius* as follows: "An incision four inches in length, commencing one and a half inches above and to the inner side of the anterior superior iliac spine, is carried down, curving slightly, with concavity below, to within half an inch of Poupart's ligament, a little below its centre. The muscles are divided in order, the peritoneum exposed and pushed back as in the former method, and the vessel reached. This method enables one to reach the artery higher up, but Cooper's operation is more easily performed."

Ligation of the femoral artery is usually performed at the base of Scarpa's triangle, at its apex, and in Hunter's canal. With the hip a little flexed and the thigh abducted and rotated outward, a line drawn from midway between the anterior superior spine of the ilium and the symphysis pubis to the tuberosity of the internal condyle will indicate its course. The centre of Poupart's ligament is to the outer side of the line of the vessels.

Ligation of the common femoral is best done at the base of Scarpa's triangle. The patient lies upon the back, with the hips a little flexed, the thigh abducted and rotated outward, the knee bent, and the leg resting on its external surface. The surgeon stands on the outer side of the limb, and cuts from above downward on the right, and *vice versâ* on the left. An assistant stands on the opposite side (Figs. 63–67).

An incision two inches in length, commencing just above the centre of Poupart's ligament, is made downward directly over the course of the artery. The fatty tissue covering the fascia lata having been reached, is divided, care being taken not to injure any of the lymphatic nodes and the superficial epigastric and superficial circumflex iliac veins. The cribriform fascia is divided in the line of the original wound, especial care being taken to avoid the superior external pubic, the superficial epigastric, or other arterial branches. The crural branch of the genito-

crural nerve lies on the sheath of the artery, on the outer side. The sheath being carefully opened, the needle is passed from the inner side.

Ligation of the Superficial Femoral at the Apex of Scarpa's Triangle.—Position same as in preceding operation. An incision over the line of the vessel, with its centre at the apex of the triangle, is made. Pressure, having previously been made over the saphenous vein where it joins the deep femoral, will outline the course of the superficial veins. The saphena will generally be to the inner side of the incision. The integu-
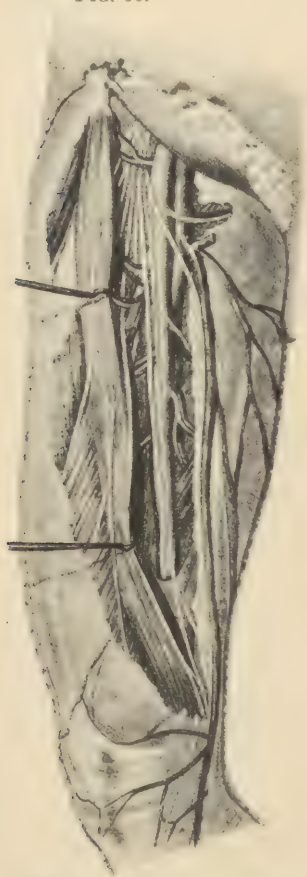
Fig. 66.   Fig. 67.

Surgical anatomy and ligation of the femoral artery (Bernard and Huette).

ment and superficial fascia having been divided, the deep fascia is divided and the inner border of the sartorius muscle is sought for, it being the guide to the artery, and is recognizable by the course of its fibres *downward* and *inward*, underneath which the sheath of the vessels will be found. The muscle, having been detached with the finger, is held outward with a retractor, exposing the sheath, the artery in front, and the vein behind, the long saphenous nerve generally, and sometimes a nerve to the vastus internus lying on the vessel. The sheath having been carefully opened, the needle is passed from within outward, caution

being used to avoid injury to the vein. If the vein is wounded by the needle, it should be closed by a small ligature and the ligature applied to the artery higher up. A needle curved laterally will be more readily passed under the vessel.

Ligature of the Superficial Femoral in Hunter's Canal.—Position same as in preceding operation. An incision three and a quarter inches long is made over the course of the vessels in the middle third of the thigh. In the subcutaneous tissue will be found the anterior division of the internal cutaneous nerve, and to its inner side the long saphenous vein, which must be drawn to the inner side. The fascia lata is now divided in the line of the primary incision, the sartorius muscle exposed, and its anterior outer edge drawn inward. The leg being now well abducted, making prominent the fibres of the adductor magnus and the lower border of the adductor longus, the site of Hunter's canal, lying between the adductor magnus and the vastus internus, will be well defined.

Clearing away any fatty tissue that may obscure, the part of the fascia forming the roof of Hunter's canal, with its fibres running transversely, will be made distinct. At this point, at the outer side of the wound, the nerve to the vastus internus must be looked for. Opening the canal in the line of the wound, the artery is exposed, and the needle may be passed from either side. In front and to the inner side will be found the internal saphenous nerve, which must be avoided and care taken not to injure the vein (Figs. 66 and 67).

Ligature of the popliteal artery is rarely required. Bryant says:[1] " I hardly know under what circumstances this artery may require the application of a ligature, except for a wound ; as for rupture of the artery or for aneurism, the operation is as inapplicable as it would be unsuccessful."

The vessel may be reached in its upper part by an incision along the outer border of the semi-membranosus muscle, and in its lower by an incision between the heads of the gastrocnemius. In the upper part the vein lies to the outer, and in the lower to the inner, side of the artery. The needle should be passed from without inward above, and from within outward below. The nerve is still more superficial, and above is still farther out, lying over the artery at the back of the knee, and to the inner side beneath the gastrocnemius.

Ligature of the Posterior Tibial Artery.—A line drawn from the centre of the popliteal space to a point midway between the inner malleolus and the heel will correspond to the lower half of the artery. The upper half curves slightly inward from this line.

In operations on this artery the patient lies on the back, the knee flexed, the leg lying on the outer side, the feet on the table, secured in this position by an assistant. The surgeon stands on the outer side of limb (Figs. 68 and 69).

In the middle of the calf an incision, four inches in length, in the middle third of the leg is made, parallel to the inner margin of the tibia and three-quarters of an inch behind its crest. After dividing the skin care must be taken not to injure the internal saphenous vein, which should be drawn aside. The fibres of the deep fascia, all of which are transverse, are divided and the margin of the gastrocnemius brought into

[1] *Surgery,* p. 376.

view.   The soleus is next exposed and divided the length of the incision, the aponeurosis with its fleshy fibres being cut through.   Here the knife should be held perpendicular to the muscle, its edge directed toward the tibia and the blade nearly horizontal.   The fascia covering the vessels and the deep muscles of the leg is now exposed, and the artery can be felt lying near the outer border of the tibia.   The nerve lies to the outer

Surgical anatomy and ligation of the posterior tibial artery (Bernard and Huette).

side of the artery.   The veins are very conspicuous, and may hide the vessel, and in all probability will have to be included in the ligature. The needle must be passed from the nerve.

Ligature in the lower third of the leg is applied by an incision two inches in length along the line of the artery midway between the margin of the tendo Achillis and the inner edge of the tibia.   The superficial and deep fascia are divided, as well as the annular ligament at its upper

part. The artery will be found lying on the flexor longus digitorum muscle, with the nerve to the outer side. The needle is passed from the nerve, and the venæ comites may have to be included.

Ligature behind the Malleolus.—A curved incision, two inches long, is made about one-half an inch behind and parallel with the margin of the inner malleolus, the knife being directed toward the tibia. The internal annular ligament is divided over the artery. The vessels and nerve lie in a gap between the tendons, and can be readily made out by the touch. Separating the artery from the vein, the needle is passed from within outward (Figs. 68 and 69).

Ligature of the Peroneal Artery.—The patient lies upon the sound side, almost on the abdomen, with the knee slightly flexed and the leg held firmly on the table on its antero-internal surface. An incision, three and half inches long, is made parallel with and immediately behind the outer border of the fibula, the centre of the incision corresponding to the middle of the leg. The fascia having been divided, the soleus muscle is exposed and drawn inward. It may be necessary to sever the lower fibres of this muscle which arise from the upper third of the fibula. Drawing it aside, exposing the fibula, the fibres of the flexor longus pollicis are severed close to the fibula until the membranous wall of the canal enclosing the vessels is exposed. Carefully laying this open, the artery is found lying against the inner margin of the fibula. The needle may be passed from either side, including the venæ comites (Figs. 70 and 71).

Ligature of the Anterior Tibial Artery.—The course of this artery will be found under a line from midway between the head of the fibula and the outer tuberosity of the tibia, extending down to the centre of the ankle-joint in front. The patient lies upon the back, the limb straight upon the table, fully rotated inward, with the foot projecting beyond the table and forcibly extended.

In the upper third of the leg an incision, three and a half inches long, is made along the line of the artery, its upper end about one inch below the head of the tibia. The deep fascia is divided along the same line, and the interval between the tibialis anticus and the extensor communis digitorum made out. The foot is now flexed to relax these muscles, and the space between them opened up by finger or handle of scalpel, the external border of the tibia being distinctly made clear to the touch before the artery is sought for, the extensor communis being held down by the fingers of the left hand, while an assistant holds the tibialis anticus toward the tibia with a retractor (Figs. 70 and 71).

The artery will be found lying on the interosseous membrane to the outer side of the border of the tibia, covered and held down by a moderately dense connective tissue. A second retractor now holds back the extensor communis, and the artery is exposed. The venæ comites may have to be included in the ligature. The nerve lies to the outer side of the artery, and, as it sometimes does not join the artery until the middle third of the leg is reached, may not be seen. The needle is passed from without inward.

In the middle third of the leg make an incision three inches long over the line of the artery. The deep fascia, being exposed, is divided in the interval between the tibialis anticus and the extensor communis

digitorum, the latter being tendinous at this point. The foot is flexed and the muscles separated with the handle of the scalpel, keeping in the direction of the tibia. The artery will be found on the interosseous membrane, the extensor pollicis to the outer side. The nerve will be exposed before the artery is reached, as it lies in front of the vessels. The needle may be passed from either side. The venæ comites may be

FIG. 70.   FIG. 71.
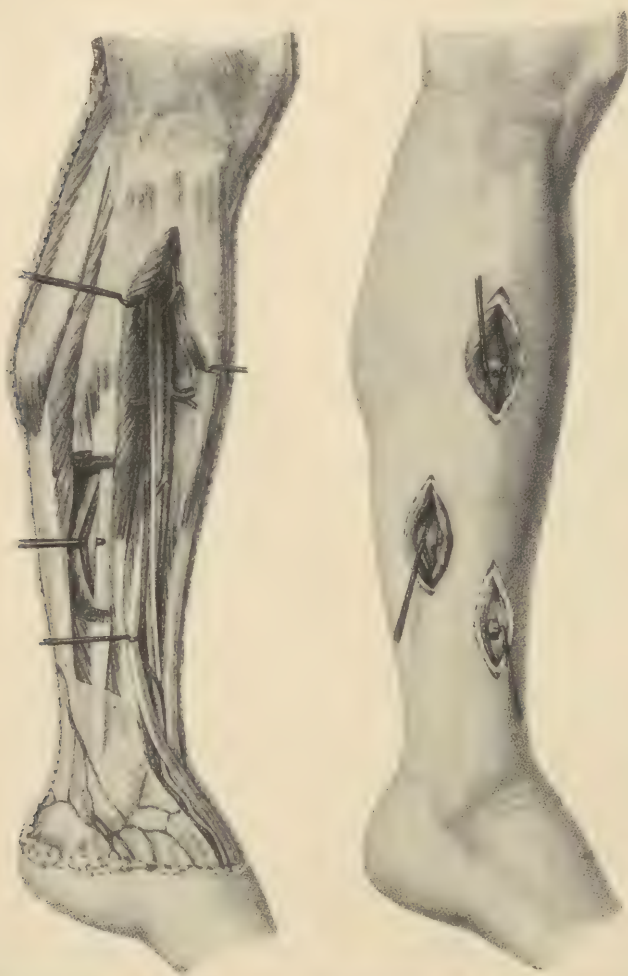
Surgical anatomy and ligation of the anterior tibial and peroneal arteries (Bernard and Huette).

included in the ligature, but the nerve must be carefully protected from injury (Figs. 70 and 71).

Ligature in the lower third of the leg is applied by an incision two to two and a half inches in length over the line of the artery, and just to the outer side of the tendon of the tibialis anticus, identifying with certainty the tendon. The foot need not be quite so much rotated as in the preceding operation. The deep fascia, or upper band of the annular

ligament, is divided in the same line, and the tendons of the tibialis anticus and extensor pollicis exposed and defined. The artery will be found between them on the front of the tibia, imbedded in fatty connective tissue. The foot being slightly flexed, the tendon of the extensor pollicis is drawn to the outer side with a blunt hook, exposing the artery. The nerve lies to the outer side, and the needle should be passed from it. The venæ comites can be readily separated (Figs. 70 and 71).

Ligature of the Dorsalis Pedis Artery.—This vessel extends from the centre of the front of the ankle, midway between the malleoli, to the middle of the first interosseous space. The patient lying on the back, the heel is steadied firmly on the table. The surgeon stands on the outer side of the foot, cutting from above downward on the right, and *vice versâ* on the left.

An incision commencing at the lower border of the annular ligament, one and a half inches long, is made over the course of the artery, and will be between the tendons of the extensor pollicis and the inner tendon of the extensor communis digitorum. The dorsal fascia is divided in the same line, and the vessel will be found imbedded in the connective tissue close to the bone. The ankle should be slightly relaxed as the vessel is sought for. The needle should be passed from the outer side to avoid the nerve.

CHAPTER IV.

SURGICAL DISEASES AND INJURIES OF THE RESPIRATORY ORGANS.

By D. Bryson Delavan, M. D.

Inspection and palpation of the exterior of the neck in the neighborhood of the larynx and trachea will sometimes demonstrate deviations, deformities, and the degree of mobility of these organs. Auscultation of the larynx by means of the stethoscope is sometimes useful in cases of foreign bodies, tumors, and the like. Palpation applied to the pharynx and the entrance of the larynx is occasionally valuable. No method, however, is comparable with the laryngoscope, by which the interior of the larynx and trachea can be directly demonstrated.

Œdematous laryngitis is a serous, sero-purulent, or purulent infiltration of the submucous cellular tissue of the larynx, and is, practically speaking, an acute cellulitis. The frequency of its association with erysipelas has often been observed. The œdema may be situated above, at, or under the glottic aperture. It is generally above and in the aryteno-epiglottic folds and the ventricular bands, which, with the epiglottis, may become enormously swollen and entirely occlude the larynx. The swelling is usually bilateral. Unless resolution takes place the infiltration may become sero-purulent, and later purulent, resulting in abscess.

Œdema of the larynx may be *inflammatory* or *non-inflammatory*, *acute* or *chronic*.

The *non-inflammatory* form may occur from certain non-surgical causes.

Inflammatory œdema may develop from an attack of acute catarrhal laryngitis or complicate erysipelas of the pharynx.

Symptoms.—The chief local symptoms are dyspnœa, aphonia, dysphagia, with, occasionally, cough, and a sensation of marked irritation in the throat. The laryngoscope reveals intense congestion of the larynx and often of the adjacent parts, with the characteristic swelling of the arytenoids and the epiglottis. The latter may attain such size as to entirely occlude the larynx, and thus produce asphyxia. The false vocal bands are sometimes implicated. The disease may be unilateral, but is more often symmetrical.

Treatment must be prompt. In early stages applications of cold in and outside of the larynx, or, if better borne, steaming inhalations (tr. benzoin. co., acid. carbolic., or tr. opii, of either, ʒj–Oij). The administration of a slightly purgative dose of calomel is often valuable. Vocal and physical rest. To relieve temporarily, local applications of a 4 per cent. solution of cocaine. Should œdema become severe, scarification, performed with the concealed laryngeal knife, aided by laryngoscopic demon-

stration of the parts, or with Buck's scarificator. *Following* scarification, application of cocaine to the larynx, as suggested by the writer, for the purpose of constricting the œdematous tissues and, if possible, emptying them. If necessary, quick tracheotomy, in which the simplest methods are permissible, for want of better, as long as the asphyxia is relieved.

The value of the *O'Dwyer tube* in these cases has often been proved. Besides relieving the dyspnœa, its pressure upon the infiltrated parts may actually hasten the disappearance of the œdema. These cases should be watched throughout with the closest vigilance.

Injuries to the Larynx.

Contusion of the larynx has sometimes been observed. Its results may be slight and limited to the rupture of a few submucous vessels, or extravasation may be extensive and dangerous. Complicating fractures or dislocations of the cartilages may cause rupture of blood-vessels, nerves, or ligaments.

The SYMPTOMS are aphonia and dyspnœa, the latter sometimes severe. Laryngoscopic examination will usually reveal the nature and seat of the lesion. TREATMENT of moderate extravasation when seen early consists of local rest, cold, and application of astringents.

Wounds of the larynx and trachea generally complicate more extensive injuries of the neck, involving division of the great vessels and speedy death. Sometimes the larynx or trachea may be wounded, the cervical vessels receding before the knife, and thus escaping injury. (*Vide* Chapter V.)

Inflammation or septic infection is a more frequent source of danger in the smaller wounds, and in the larger ones necrosis, inhalation of detached fragments, growth of granulations, secondary hemorrhage, tracheo-bronchitis, pleurisy, and broncho-pneumonia. Death in from eleven to fourteen days, and recovery in uncomplicated ones in from thirty to forty. Defective voice, laryngeal stenosis, and tracheal fistula sometimes result. The PROGNOSIS is serious, especially in the case of small penetrating wounds. TREATMENT must be prompt and energetic. Union by first intention is unusual. Provision should therefore be made for drainage. Usually hemorrhage must be checked and asphyxia prevented. The air-passages must be cleared of blood, partly detached fragments of tissue removed, a tracheal cannula inserted, the strength of the patient sustained, and the indications in special cases actively met. Tracheotomy may be required, on account of asphyxia and to relieve hemorrhage, which the asphyxia increases. If necessary the tampon-cannula should be employed. Some recommend a preventive tracheotomy where the constant attendance of a surgeon cannot be secured, in view of the danger of displacement of the wounded parts or of sudden œdema. This, however, is not always necessary. Sometimes the introduction of a large catheter or other suitable cannula may give the required relief. Where the wound is near the crico-thyroid space intubation may sometimes be valuable.

Fracture of the Larynx.—Most common in men, and is generally due to direct violence. It may be simple or compound, incomplete or complete. The thyroid is most often implicated, the cricoid next, while

fracture of both is unusual, and that of the arytenoids very rare. Fracture may be complicated with fractures and wounds of neighboring parts and with injury to the external jugular vein.

The SYMPTOMS, varying in severity, are functional disturbance, expectoration of frothy blood or of bloody mucus at or shortly after the time of the accident, stridulous respiration, dyspnœa, more or less aphonia, dysphagia, and sharp pain in the larynx, increased on pressure. Inspection will reveal swelling and ecchymosis, and over the larynx itself various irregularities, with unusual flexibility, mobility, or even crepitation of the cartilages. All of the latter signs may be absent.

The symptoms are sometimes slight and recovery speedy. Generally, they are either severe from the first or gradually become so. Later, the danger is from abscess, necrosis of fragments, and the formation of deforming cicatrices and consequent stenosis of the larynx.

The PROGNOSIS is serious, and the rate of mortality very high, especially in fractures of the cricoid. Resulting cicatricial stenosis of the larynx may make the permanent wearing of a tracheal cannula necessary.

DIAGNOSIS is easy except where there is little displacement and much swelling.

TREATMENT.—Several methods of treatment have been recommended : while some cases have recovered without surgical aid, tracheotomy has generally been advised when dyspnœa threatens. In fractures with displacement tracheotomy may be followed by attempts at replacement of the fragments and their retention in position by means of a suitable support. Some advise a thyrotomy and the separation of the two halves of the larynx until the fragments have united in good position, or, if some have become detached so as to obstruct the larynx, to either replace or remove them. Wagner performs thyrotomy, asepticizes the wound, replaces or removes the fragments of cartilage, and packs the cavity of the larynx with iodoform gauze.

In some cases intubation may be found useful. In fracture of the trachea, a rare condition giving a bad prognosis, the symptoms are dyspnœa, extravasation, and emphysema, with pain on pressure over the seat of the fracture. For treatment, complete quietude and, if dyspnœa occur, tracheotomy.

Burns of the air-passages may be caused by the inhalation of flame or steam or by the swallowing of hot or caustic liquids. Such accidents are quickly followed by acute inflammation, and sometimes by considerable swelling. Inflammation may extend to the trachea, bronchi, and lungs.

The early SYMPTOMS are pain, dyspnœa, dysphagia, aphonia, and shock. Respiration is rapid and stridulous, the countenance pale and anxious, and there is marked restlessness. The symptoms may be mild at first, but later severe, especially after the ingestion of caustic liquids. Often œdema of the larynx and fatal dyspnœa soon supervene, or, if these are escaped, pulmonary complications quickly follow.

The DIAGNOSIS may be made from the history of the case, and, when this is unobtainable, from the lesions visible in the buccal cavity.

Mild cases may recover in a few days. More often death results in from one to two days from shock or dyspnœa, or later from laryngitis,

bronchitis, and pneumonia. Cicatricial stenosis of the larynx often results.

TREATMENT.—The inhalation of flame or of steam is always a grave accident, complicated as it usually is by other injuries or burns, and by physical depression and severe mental shock. Absolute quiet should be secured, the strength supported, the digestion regulated, and the patient carefully watched for the development of serious respiratory symptoms. Many have recommended the administration of calomel. Warm inhalations, containing a small proportion of opium (tr. opii ʒj, boiling water Oj), are sometimes successful in relieving irritation and quieting glottic spasm and cough.

When œdema is imminent, if the case is seen early, cracked ice, held in the mouth, will often subdue the inflammation and quiet the pain. The patient must not be left unwatched for a moment, and if œdema occur prompt aid must be afforded by scarification and the subsequent application of cocaine. Often urgent dyspnœa develops with startling rapidity, requiring instant relief by intubation or tracheotomy. Where caustic fluids have been swallowed neutralizing agents should of course be resorted to if the case be seen in time.

FOREIGN BODIES IN THE AIR-PASSAGES.

Liquids accidentally drawn into the larynx or trachea are usually expelled by efforts of coughing. When there is laryngeal insensibility it is more serious. The only symptoms may be severe dyspnœa and the existence of moist tracheal râles. Death follows at once or is caused secondarily by pulmonary inflammation. Spasm of the glottis and even death may be caused by the topical application to the larynx of strong medicated solutions.

The entrance of blood or pus into the air-passages may cause rapid suffocation. Pus from the pleural cavity, from an abscess of the liver or of the mediastinum, may find its way into the air-passages.

TREATMENT.—Coughing will usually suffice to expel small quantities of fluid. In severe cases, as drowning, the patient should be held with his head and shoulders directed downward, his tongue drawn well forward, and artificial respiration resorted to. Severe glottic spasm, entrance of blood or pus, may make it necessary to do tracheotomy and remove the fluid by aspiration.

Solids.—The entrance of a foreign body into the air-passages must always be regarded as one of the most serious of accidents. Introduction through an external wound is unusual.

The variety of bodies which may be inhaled is unlimited. Their size is necessarily restricted to the diameter of the glottic aperture. Of course upon the size, shape, nature, and seat of lodgement of the object will depend largely the degree of harm which it may inflict.

Foreign bodies may simply lodge in the larynx itself, or may be detained in one of the ventricles or wedged in the rima glottidis. They may become fastened in the trachea, or descend to its bifurcation, or through one of the greater bronchi into one of the more remote bronchial tubes. The right bronchus is more apt to be the seat of lodgement than the left.

The SYMPTOMS vary somewhat with the size, shape, and position of the foreign body. They are sometimes extremely obscure. The primary symptoms are—violent spasm of the larynx, choking, cough, and distress; sometimes vomiting occurs, with relaxation of the sphincters. Blood may be coughed out immediately after the accident. The dyspnœa may prove speedily fatal, especially when a large body suddenly occludes the larynx. The body is sometimes coughed out. Often these symptoms subside after a time, but certain signs remain, suggesting its presence. The accident may be unrecognized, because the initial dyspnœa and cough may, in some cases, be lacking. The voice may be affected. Later symptoms are—modification of the voice, continued discomfort, quickened respiration, cough accompanied with expectoration of frothy or bloody sputum. If the foreign body is fixed, the symptoms may tend to subside; but if it be movable, a change in its position is very apt to be accompanied with fresh attacks of the urgent symptoms. The general condition of the patient may not suffer, but, on the other hand, very rapid loss of strength, appetite, and weight may ensue.

A foreign body in the trachea may cause severe reflex cough, together with certain changes in the current of inspired air heard upon auscultation. Lodged in one of the bronchi, unless relieved it will almost certainly cause death. Following the exclusion of the air, pneumonia may readily develop, or, if the foreign body be particularly irritating in its character, abscess or gangrene of the lung may be established. In such a case the diagnosis will often be a matter of extreme difficulty unless a clear history of the inhalation of the body be obtainable. Auscultation will sometimes reveal, at a certain point in the neighborhood of one of the larger bronchial tubes, such changes in the air-currents as will indicate partial occlusion.

The PROGNOSIS, always exceedingly grave, is more serious in the child than in the adult. Caustic substances or foreign bodies, such as beans, which are capable of swelling, are especially dangerous. The long-continued presence of a foreign body in the air-passages may simulate phthisis.

DIAGNOSIS.—The diagnosis, when difficult, depends upon the suddenness of attack, the absence of fever, and the fact that the patient is comparatively well between the attacks of dyspnœa or spasm. Sometimes the patient is conscious of the movements of the body in the trachea. The presence of a foreign body in the œsophagus, causing urgent dyspnœa, may generally be demonstrated by means of the œsophageal sound. When the foreign body has entered a bronchus the passage of air into the lung of that side is, to a greater or less extent, prevented. There will, therefore, be a lack of inflation and of respiratory murmur in that lung, without corresponding dulness or other symptom of acute pulmonary disease.

Laryngoscopy, aided by local anæsthesia, will often be of great assistance in demonstrating the position of the foreign body.

TREATMENT is often extremely difficult. The statistics of operation, although not satisfactory, are slightly in favor of surgical interference. In simple cases it is not good practice to excite cough, sneezing, or vomiting. Even the inverted position, assisted by percussion upon the back, is not recommended, although often effective with children choked

from the ingestion of too large morsels of food, the danger being the causing of spasm of the glottis by the impact of the body upon the vocal bands. If the foreign body is impacted in the larynx, it may be removed through the natural passages, in the case of large objects, by means of the finger or a pharyngeal forceps. Smaller bodies should be removed, with the aid of the laryngoscope, by means of suitable endo-laryngeal instruments, the parts having first been thoroughly cocainized. If the object is too large to be removed at once, it may be crushed and taken away piecemeal. If it has fallen into the trachea, one of the special O'Dwyer tubes may be inserted, in the hope that the object may be expelled through it. If it has become impacted in the larynx in such a way that it cannot be extracted otherwise, thyrotomy may be indicated, or, if the object is small, cricothyrotomy. When the body has entered the trachea, tracheotomy is required. The trachea should be opened low down, and, unless the body is easily reached and expelled, several rings should be divided and the edges of the wound widely separated, the patient inverted, and efforts made, by palpating the chest or by exciting cough, to cause its expulsion. If necessary, long, slender forceps may be used for dislodging it. Sometimes the foreign body will remain *in situ* for several days.

PERICHONDRITIS OF THE LARYNX.

Perichondritis of the larynx is an inflammation of the perichondrium and of the cartilages, sometimes followed by caries or necrosis of the latter. It is generally secondary, and rarely primary. Among its most common causes are tubercular, specific, and cancerous ulceration of the larynx. It may also follow typhoid fever, variola, scarlet fever, erysipelas, and pyæmia. It is sometimes occasioned by injury. When the perichondritis is due to deep ulceration, necrosis of the cartilage is apt to follow through impairment of its nutrition. Separation of the fragment sooner or later takes place. In some cases the destructive process is rapid and the seques-trum is quickly detached. Deformities, often leading to stenosis of the larynx, and sometimes to fistulous openings of it, and ankyloses, particularly of the crico-aryte-noid articulations, are some of its results.

The SYMPTOMS are often obscure and not characteristic. Generally the pain will be increased by external manipulation of the larynx, and dysphagia and dysphonia may be present. Laryngoscopic examination, aided by the use of the laryngeal probe, may demonstrate the existence of exposed cartilage, and fragments of the latter may be expectorated or may hang more or less loosely in the laryngeal cavity. The results of direct examination may differ somewhat in accordance with the seat of the affection. At the affected point an abscess may develop.

DIAGNOSIS is made by exclusion and laryngoscopic examination. External palpation and inspection are often useful, while the fact that the concurrent disease may be attended with this complication will afford aid.

The PROGNOSIS will depend upon the cause. Suppurative perichon-dritis with necrosis is often very serious, because of immediate accidents and ultimate laryngeal stenosis. In tubercular and malignant disease the prognosis is bad. In syphilis, however, the prompt and energetic use of iodide of potassium, given in frequent doses, is most effective. The iodide may be best administered in milk thickened with pepsin, in the proportion of ten grains of iodide, one drachm of essence of pepsin,

and four ounces of milk. This, made into junket, is palatable, nutritious, and easily swallowed. Where the symptoms are acute use active measures, such as application of cold compresses, sucking of ice, scarification of œdematous tissues, and the prompt opening of abscesses. In evacuating the latter the incision should be made quickly, and the patient placed so as to enable him to rapidly expel the discharged pus. For urgent dyspnœa perform tracheotomy or insert an O'Dwyer tube. The effect of the iodide of potassium will generally render this unnecessary. These patients should be watched for a long time, and any tendency to deformity of the larynx, if possible, counteracted.

Stricture of the Larynx,

other than that due to inflammatory thickening and to new growths, consists of permanent deformity, the result of previous disease or injury, and caused either by displacement of the parts or, as is most commonly the case, by the presence of deforming cicatrices. Fractures, perichondritis, chondritis, ankylosis of the arytenoid articulations and " web of the larynx," may occasion it, but it is generally due to injury or ulceration of the soft tissues which line the larynx, commonly from tertiary syphilis, and also to other diseases causing deforming cicatrices, and to destruction of the soft parts due to burns. Stenosis of the trachea may occur at various parts of this canal from the formation of bands of fibrous tissue which distort the tracheal rings. Sometimes the strictures are multiple. Between them are occasionally seen dilatations of the tube.

The symptoms may be divided into three stages—that of active disease, that of stenosis, and, finally, that of suffocation. Again, they may at first be mild and progressive, beginning with slight laryngeal stridor. This increases, being especially marked on inspiration, and is later accompanied by dyspnœa, and often by change in the quality of the voice, which becomes hoarse in stenosis of the larynx or simply weak in stenosis of the trachea. Later, dyspnœa increases. Respiration is feeble and slow. The attacks of urgent dyspnœa are apt to take place at night, and are due to spasm of the glottis. Death may be caused by sudden asphyxia or by pulmonary congestion, pneumonia, and œdema. Sudden death from syncope will sometimes occur, due to an inhibitory action upon the bulbar centres. In stenosis of the trachea the point of greatest constriction may sometimes be determined by auscultation, as well as by laryngoscopic examination.

In diagnosing this condition the existence, position, and character of the stricture must be established. It has been said that if hoarseness has preceded dyspnœa the stenosis is in the larynx; if dyspnœa preceded, it is tracheal.

A mediastinal tumor, possibly compressing the trachea or bronchi, may be revealed by examination of the chest; tumor of the neck may be recognized by palpation of this region, and a laryngoscopic examination will establish the differential diagnosis between paralyses, tumors of the larynx, and actual stenosis.

The prognosis is serious, especially in stenosis of the lower part of the trachea, which is almost necessarily fatal.

The treatment consists especially in dilatation of the stenosed

parts. Should this fail, the permanent use of a tracheal cannula is always possible. For the actual relief of the stenosis the application of intubation has accomplished much. This may be greatly assisted by the careful and judicious division of constricting bands of cicatricial tissue before the tube is introduced. In the case of a congenital web of the larynx the simple wearing of the tube or, if necessary, removal of the web before the introduction of the tube, has given brilliant results. The patient should be examined at short intervals, the tube occasionally removed, and, if necessary, a larger one inserted in its place. This treatment should be continued until the necessary enlargement of the interior of the larynx is secured. Failing in other means, thyrotomy and excision of the offending cicatrices.

Fistula of the Larynx and Trachea.

The distinguishing sign of this condition is the passage of air through the external opening, together with mucus, and sometimes of pus and broken-down tissues. Respiration is generally normal unless there is stenosis of the larynx, but the voice is often modified by the escape of the expired air, and in some cases phonation is impossible unless attempted when the opening is artificially closed.

The external orifice of the fistula may be readily detected. Its internal opening may sometimes be demonstrated by the aid of the laryngoscope.

These cases are not serious, although sometimes difficult to cure.

The TREATMENT consists of closing of the fistula, any existing condition of stenosis of the larynx or trachea first having been removed. Small fistulæ may be closed by the application of mild caustics or of the galvano-cautery, larger ones by vivifying the edges and uniting them with sutures.

As a rule, however, some plastic operation, such as Berger's or Abbe's, will be required to thoroughly close the opening.

Tracheotomy.

Tracheotomy is a general name for several operations employed for the admission of air to the trachea where the latter, or the approaches to it, have become obstructed. These operations are crico-thyroid laryngotomy, made through the crico-thyroid membrane; laryngotracheotomy, through the cricoid cartilage and the first ring of the trachea; and the two operations most commonly resorted to, high and low tracheotomy, respectively above and below the isthmus of the thyroid.

Before attempting any of these operations it is imperatively necessary that the anatomical relations of the trachea in connection with them should be thoroughly well understood.

Tracheotomy is easier performed high in the neck than low, for the anterior jugular veins are smaller above and transverse branches are rare; the muscles are somewhat separated above, while below they are in contact; the great vessels and the inferior thyroid veins are avoided. Here, too, the trachea is nearer the surface and more readily held in position. The lower the incision in the trachea, the greater the

danger of sepsis and of broncho-pneumonia. On the other hand, particularly in the adult, the necessities of the case will sometimes demand a low operation.

FIG. 72.
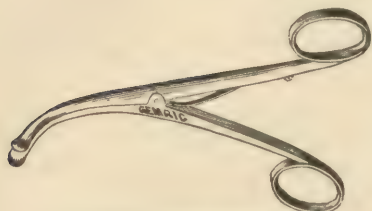
FIG. 73.

Trousseau's tracheal dilator.

Silver tracheotomy-tube.

The Tube.—The tube should be selected with careful reference to the case in hand. The one now in common use goes under the name of Trousseau. The thickness of the tissues covering the trachea varies greatly in different individuals. Durham has therefore devised a cannula the length of which from the neck-plate can be regulated by means of a screw-collar. The cannula itself is straight until within a short distance of its distal end. Certain defects of the Durham cannula have been avoided in the tube devised by Keen.

König's tube, designed for the relief of stenosis occurring low down in the trachea, is about four and a half inches long. Abbe suggests an improvised cannula for deep tracheal obstruction, made by inserting a piece of soft-rubber tubing into the trachea and transfixing its proximal end with a safety-pin.

Many different devices have been made for the performance of rapid tracheotomy. They are practically never used.

Tracheal tubes are composed of silver, aluminum, hard rubber, soft rubber, and celluloid. As a rule, metal tubes are preferred. The hard rubber-cannula, however, is very useful when the tube is to be worn but for short time, and is more comfortable, for several reasons, than metal.

The indication for tracheotomy is the presence of an occlusion of the normal opening of the larynx from acute or chronic causes, which causes dyspnœa sufficient to endanger life, which cannot be overcome by other means. The operation in itself is usually not dangerous, nor is it likely to cause serious complications to the disease for which it is employed. Its early performance where indicated, therefore, should, wherever possible, be advised.

When practicable, chloroform anæsthesia should be employed before this operation. Ether causes nausea, vomiting, and embarrassing reflex movements of the larynx. The hypodermic injection of cocaine, although recommended by some, in the experience of the writer has not always succeeded in allaying the pain.

In tracheotomizing children, especially in diphtheria, chloroform is apt to be contraindicated. Its administration may cause rapid increase of dyspnœa, and greatly complicate an operation which under the conditions of cyanosis present is not likely to create suffering.

The *operation of tracheotomy* is generally performed as follows, under chloroform unless contraindicated by dyspnœa and laryngeal irritation,

and with proper antiseptic precautions: The patient is placed upon his back near the right side of the operating-table. A suitable firm support is placed under the neck and shoulders, and the head allowed to bend backward in extreme extension. In this position the anterior

Fig. 74.

Position of patient for tracheotomy.

structures of the neck are rendered tense, the trachea steadied, drawn as far upward as possible, and brought somewhat nearer to the surface of the neck, and the superficial veins somewhat emptied. To the assistant who administers the anæsthetic is also given the duty of holding the patient's head steady and of keeping the chin exactly in the median line. The latter is very important to the surgeon, the accuracy of whose incisions is likely to be determined by the careful observance of it. At least one other assistant is desirable to attend to the bleeding and superintend the instruments and the tube.

Before making the first incision the operator should clearly define the position of the thyroid and cricoid cartilages and of the median line. With a sharp scalpel, held between the thumb and finger, an incision should be made through the integument from an inch to an inch and a half long, and precisely in the median line, downward from the level of the upper border of the cricoid, the parts on each side of the cut being steadied meanwhile by the thumb and fingers of the left hand. The movements of the thorax in respiration make it impossible to support the right hand upon the chest during the performance of the operation. Next, in the same way as above, the subcutaneous fat and the anterior cervical fascia are divided. By successive incisions, aided by the director and the handle of the scalpel, the sterno-hyoid and the sterno-thyroid muscles are reached, and the space between them opened, and the fascia covering the trachea demonstrated. Then, keeping strictly in the median line, the deep fascia is divided and the trachea laid bare. For the division of the fascia the help of a director is valuable. Any veins encountered at this point in the operation should be pushed aside with the handle of the scalpel. The isthmus of the thyroid must be similarly pushed downward, and, if necessary, held out of the way with a small blunt retractor. The tracheal rings may now be felt with the finger, the fact that the trachea is actually laid bare assured, the exact situation of the cricoid noted, and the precise position of the intended opening into

the trachea located.   A silk suture passed through the trachea on either side the opening, and then through the skin, tied, and the ends left long, makes a most serviceable retractor and guide should the tube require replacing.

For the next division of the operation the following should be in readiness and at hand—namely : A sharp scalpel or tenotomy knife, the tenaculum, the tracheal dilator, a damp towel, and, finally, the tube, properly oiled, to which a tape of length sufficient to twice surround the neck of the patient should have been passed into one of the eyelets at the side of the neck-guard.   Everything being in order and if possible all bleeding controlled, a small sharp tenaculum is passed into the cricoid cartilage in the middle line and held by the assistant, who stands behind the patient's head.   His duty is to keep the tenaculum in the median line, and with it to draw the cricoid forward and keep the trachea steady and tense.   The up-and-down movement of the larynx in respiration will make it necessary to not hold the hook too rigidly.   Having decided which rings to divide, the operator introduces the scalpel into the wound, the edge of the knife being directed upward, and, guided by the left fore finger, inserts the knife, exactly in the median line, into the lowest of the two or three selected rings (usually the first three of the trachea) and cuts directly upward toward the tenaculum.   The latter is still held in position, and the knife not removed from the tracheal incision, but turned slightly upon its vertical axis, so as to separate the sides of the opening and admit the tracheal dilator, which is next inserted, and the opening sufficiently dilated to enable the tracheal tube to be passed.   This should be done as easily and expeditiously as possible, and the tube at once secured in position by passing one end of the tape around the patient's neck, through the unoccupied eyelet of the neck-plate of the tube, and back around the neck, to be tied to its fellow.

The presence of the tenaculum in the cricoid excites such urgent reflexes of the larynx that until the trachea is opened the patient in many instances cannot breathe.   The effect of the sudden entrance of the air is to excite such expulsive efforts of cough that the mucus, blood, or membrane which may be in the trachea are projected forth with great violence.   For the protection of the operator as the trachea is being dilated, an assistant should hold a damp towel a short distance above the wound.

In no case should the tube be introduced without previous separation of the edges of the tracheal incision.   Disregard of this rule will defeat the attempt at introduction, and may result in serious injury to the parts, particularly where the rings of the trachea have become partly ossified.   Pressure against the incision only forces its edges the more firmly together, while undue force may either fracture the cartilages or, from the slipping of the tube, force it downward through the tissues on the side of the trachea, thus inflicting damage.   In such cases, where the tube must be worn habitually, it is better not to rely upon a simple vertical incision of the trachea, but to actually exsect a circular portion of the anterior wall equal in size to the diameter of the required cannula.   The result is more comfortable to the patient, and enables the cannula to be inserted more easily.   When the tube is in place the tenaculum may be removed, and the wound below the tube brought together by one, two, or three sutures.   A piece of lint properly shaped to cover and protect the wound is smeared with some antiseptic ointment and placed under the shield of the cannula.

Subhyoid pharyngotomy has, on rare occasions, been employed in

the removal of a foreign body or of a new growth situated in the upper opening of the larynx, and particularly in the neighborhood of, or in connection with, the epiglottis. It is seldom used, since the access to the larynx accorded by it is very small. In operating, a transverse incision is made through the thyro-hyoid membrane near the inferior border of the hyoid bone and parallel with it. By means of this incision the epiglottis is exposed, and, where possible, drawn through the wound. In patients in whom the neck is thick this is not easy. The growth is then removed, bleeding checked, and the wound closed. There are no important vessels in the way, and prompt healing should result. The statistics of the operation are not good, as danger from sepsis is considerable.

Infrathyroid laryngotomy has been performed for the removal of subglottic growths. In operating, the laryngotomy should be made several days before the attempted extirpation of the growths, in order to accustom the parts to the presence of the tube and thus reduce the irritation for the chief operation. In performing the latter the crico-thyroid space is well opened up and the cartilages separated as widely as possible. Space is then given for the removal of the growth, which should be effected by the aid of proper laryngeal instruments and methods, the cavity being sufficiently illuminated meanwhile to admit of thorough and accurate work. In readjusting the parts it is safer to allow a cannula to remain until the danger of obstructive inflammation of the larynx shall have subsided.

LARYNGOTOMY.

Laryngotomy, performed by opening the larynx through the crico-thyroid membrane, is sometimes employed in place of tracheotomy. The operation is not as difficult as the latter, and may be performed more rapidly. It is not applicable to children, on account of the small size of the crico-thyroid space. While it may answer for emergencies, it is not desirable where the tube must be worn for any length of time. The only important vessels to be encountered are the crico-thyroid arteries, which cross this space and are usually of small size. They may, however, be large enough to give rise to serious hemorrhage.

The after-management should be conducted with scrupulous care. For the first few days at least the patient should be under the supervision of an attendant thoroughly competent to provide the special assistance necessary in such cases. The tapes must be kept in order, and the tube frequently cleansed of secretion by withdrawing the inner cannula and cleaning it. The latter should be returned as quickly as possible. It should be thoroughly disinfected and well oiled upon its inner as well as upon its outer surface before being again introduced. In the matter of feeding assistance will sometimes be gained by the use of the œsophageal tube, especially in children.

The operation of **thyrotomy** consists in the complete division of the thyroid cartilage in the median line. It is employed in gaining access to the larynx for the removal of new growths or for other obstructive conditions, such as impacted foreign bodies, irremediable cicatricial bands, or the like. As it is likely to cause impairment of the voice, it should not be undertaken unless clearly indicated through failure of endolaryngeal methods to attain the desired end. On the other hand,

in certain serious conditions it affords the best possible opportunity for the thorough accomplishment of the purpose for which it is performed, and in good hands has been attended with excellent results.

A preliminary laryngotomy or tracheotomy is required, and should be performed a number of days before the main operation. The selection of the point at which the tube is to be inserted should depend upon the situation of the growth and the probable length of time that the tube will have to be worn. Should extensive bleeding be expected, a tampon-cannula must be used. In performing the thyrotomy the incision already made is prolonged upward from the median line and the tissues divided down to the cartilage, the cut extending upward to some point in the thyro-hyoid space. In dividing the thyroid cartilage it is customary to carry a perfectly true incision accurately in the median line, the crico-thyroid membranes being also divided as far as is necessary. The division of the cartilage should be effected from above downward and from without inward, and may be accomplished by means of a small but strong knife in patients in whom the thyroid has not begun to calcify. In case the latter condition is present, brilliant results have been gained by the electric saw, as recommended by Wagner. A strong scissors may also be used for the purpose. The dissection having been accomplished, the wings of the thyroid are drawn apart by means of two small sharp retractors or by means of threads passed through them, and the interior of the larynx is thus exposed. In closing the wound the two halves of the thyroid are united by two or three sutures of fine silver wire and the superficial wound closed.

The subsequent treatment, in the main, will be such as is carried out after tracheotomy, special indications being met and the interior of the larynx meanwhile not being neglected.

When thyrotomy has been performed for the removal of a new growth, however, and considerable injury done to the soft part of the interior of the larynx, much better results will be obtained by keeping the edges of the thyroid apart until the healing of the deeper structures shall have been completed. Some of the best operators remove the tube at once after the completion of the operation, and allow the patient to breathe through the thyroid opening. In the removal of a malignant new growth the necessity for the thorough illumination of the larynx will be apparent. For this purpose a forehead reflector should be provided, and, if possible, a small Edison incandescent lamp of two or three candle-power. The application of cocaine to that part of the larynx which is occupied by the growth will render it easier to distinguish the diseased areas and lessen the amount of bleeding. In the after-treatment the larynx is kept open, the surface of the wound dusted two or three times a day with iodoform powder or iodoform and boracic acid, equal parts; the patient's head kept low, and the external wound covered with iodoform gauze. The patient may be able to swallow liquid food at an early date by keeping the head low during the attempt.

Thyrotomy as employed for the removal of malignant disease of the larynx was formerly singularly unsuccessful. In late years, however, the results obtained by it have been increasingly better, and at the present time it promises to rank as one of our most valuable aids in such conditions.

In performing operations of this class it is sometimes necessary to prevent blood from entering the trachea, which may be accomplished either by packing the latter with sponge or gauze, or by means of a device know as the tampon-cannula. This instrument is a tracheotomy-tube around the outside of which is attached a dilatable sac of India-rubber, which, being inflated when the apparatus is in position, effectually occludes the trachea above the opening of the tube. Excellent modifications of the original Trendelenberg cannula have been made by Roswell Park, Hahn, Gerster, and others.

INTUBATION OF THE LARYNX.

Intubation of the larynx, as perfected and established by Dr. Joseph O'Dwyer, is a most valuable addition to the surgery of this department.

Intubation Instruments.—A set of instruments for children under the age of puberty consists of six tubes, of different sizes and varying in length from one and a half to two and a half inches; an introducer, an

FIG. 75.
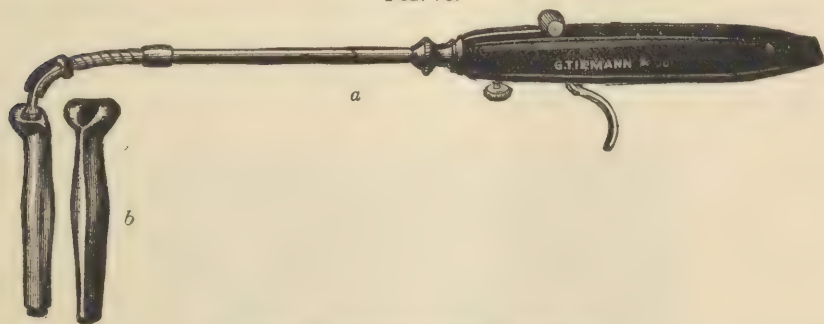
O'Dwyer's laryngeal tube and introducer.

extractor, a mouth-gag, and scale of years. Each tube is provided with a separate obturator for the purpose of attaching it to the introducer. The numbers of the scale represent years and indicate approximately the ages for which the corresponding tubes are suitable. The female larynx in children as well as in adults is smaller than in the male.

In measuring the tubes the heads are of course included.

Having selected the tube, a strong thread is passed through the small eyelet at its head, and the ends tied together. Braided silk is the best, and the piece should be sufficiently long to reach the stomach and still leave a portion protruding from the mouth. The obturator is then screwed firmly up on the introducer to prevent the tube from rotating while being inserted, and fixed so that the long diameter of the tube

FIG. 76.

Mouth-gag.

when applied and ready for use is in a line with the handle of the introducing instrument.

Indications for Intubation.—The indications for intubation in children are the same as for tracheotomy. There is no reason why one

Fig. 77.
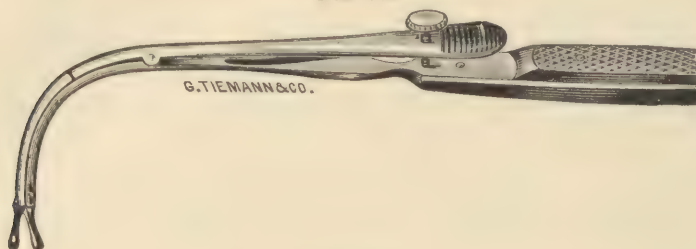
Extractor.

should be performed earlier than the other. The beginning of the suffocative stage is the proper time to interfere. Marked cyanosis is too late a symptom to wait for, and, besides, fatal obstruction may exist in the glottis with extreme pallor of the surface.

The method of intubation applies to any obstruction of the larynx not due to a foreign body.

Method of Operating.—The person who holds the child should be

Fig. 78.

Intubation of the larynx.

seated on a solid chair with a low back, and the patient placed as represented in Fig. 78. Fastening the hands in front of the chest, or thick garments in the same location, render it more difficult to depress the handle of the introducer sufficiently to carry the tube over the dorsum of the tongue.

The gag is then inserted well back, behind or between the teeth in the left angle of the mouth, and the jaws very carefully separated. In children who have not at least one bicuspid on the left side, the finger should be used instead of the gag. An assistant holds the head firmly, at the same time slightly elevating the chin. The operator stands in front of the patient, holding the introducer lightly between the thumb and fingers of the right hand, the thumb resting on the upper surface of the handle just behind the knob that serves to detach the tube, and the index finger in front of the trigger support underneath. Held in this manner, it is impossible to use undesirable force.

The index finger of the left hand is carried well down in the pharynx or beginning of the œsophagus, and then brought forward in the median line, raising and fixing the epiglottis, while the tube is guided along beside it into the larynx. If any difficulty is experienced in locating the epiglottis, it is better to search for the cavity of the larynx, into which the tip of the finger readily enters, and which cannot be mistaken for anything else. Once in this cavity, the epiglottis must be in front of the finger. The latter is then raised and pressed toward the patient's right to leave room for the tube to pass beside it. The distal extremity of the tube should be kept in contact with the finger, and even directing it a little obliquely toward the right side of the larynx is necessary to get inside the left aryteno-epiglottic fold, especially in very young children. The handle of the introducer is held close to the patient's chest in the beginning of the operation, and rapidly raised as soon as the lower end of the tube has passed behind the epiglottis, otherwise it will slip over the larynx into the œsophagus.

When inserted the cannula is detached by pressing forward the button on the upper surface of the handle of the introducer with the thumb, and in removing the obturator the movements required for insertion are reversed. To prevent the tube from being also withdrawn, the finger must be kept in contact with its shoulder either on the side or posteriorly, and the tube should be carried well down in the larynx before it is detached.

The gag is removed as soon as the tube is in place, but the string is allowed to remain long enough to be certain that the dyspnœa is relieved and that no loose membrane exists in the lower portion of the trachea.

In withdrawing the tube the child is held as in introducing it, and the extractor is guided along the side of the finger, which is brought in contact with the head of the cannula, and then pressed toward the patient's right, in order to uncover the aperture and allow the instrument to enter in a straight line. No attempt at extraction should be made until the head of the tube is felt.

Introduction of the tube must be accomplished quickly, the whole performance not occupying more than ten seconds.

To place a tube in the larynx of a struggling, choking child in the brief space of time that is compatible with safety is a difficult thing to do, and should not be attempted, except in case of emergency, without previous practice on the cadaver or on the larynx of an animal removed and placed in a suitable position.

The proper time for removing the tube from the larynx will depend on the age of the patient, the character of the disease, whether of slow or rapid development, and the progress of the case. In diphtheria the younger the patient, as a rule, the longer the tube will be required. In children under two years of age it is better to leave it in seven days. When the above disease has developed slowly, and has therefore run a greater part of its course before calling for operative interference, the tube can be dispensed with earlier—sometimes as soon as the second or third day. If the case cannot be seen within a reasonable time, it is safer, if progressing favorably, to leave the tube in position for seven or eight days, and the exceptions are few in which it will be necessary to reinsert it after this time.

The tube should always be removed on the recurrence of severe dyspnœa, because it is sometimes impossible to ascertain with certainty whether it be partially obstructed or not. The best evidence to the contrary is a good respiratory murmur or numerous râles over the lower posterior portion of the lungs. Even under these circumstances the lumen of the tube may have been encroached upon. In cases refusing nourishment after intubation it is useless to remove the tube for the purpose of feeding, unless it has been in long enough to give some reasonable hope that its further use will not be necessary, as it is difficult to convince children for some time that they can swallow any better than before. If no dyspnœa recur in half an hour after the extraction of the tube, it is safe to leave the patient, if not at too great a distance to be reached within two or three hours.

Accidents and Dangers of Intubation.—The most serious of the accidents incident to this operation is apnœa from prolonged attempts in unskilful hands to introduce the tube. Ten seconds is the longest time that should be occupied in each attempt if the child be suffering from urgent dyspnœa at the time. If the finger be then removed from the mouth and the patient be given a chance to get his breath, many attempts to properly place the tube can be made without danger, although the expert seldom requires more than five seconds to complete the operation, except in difficult cases. In these, if necessary, an anæsthetic may be used.

If the tube have once passed on the outside of the larynx, and this is recognized before it is detached from the obturator, it is useless to try to rectify the position without first depressing the handle of the introducer, as in the beginning of the operation.

The tube may be passed into one of the laryngeal ventricles and a false passage made if care be not taken to pass it in the median line. If the patient's head be thrown too far back, the tube may also be arrested by coming in contact with the anterior wall of the larynx or trachea.

Pushing down membrane before the tube is the most serious of the unavoidable accidents attending this operation. In several such cases removal of the tube has been followed by expulsion of complete casts of the trachea, although in none of these cases was the dyspnœa relieved by the ejection of the membranes, and the immediate reintroduction of the tube was necessary because the obstruction was in the glottis.

Where the child is inclined to injure the string with his teeth, the difficulty may be overcome by passing the thread between two of the double teeth. When this plan cannot be adopted, a smaller tube than the one suitable for the age should be used, which seldom fails to be rejected if obstructed.

In the event of sudden asphyxia the nurse should hold the child head downward, at the same time shaking it or slapping it vigorously upon the chest. Serious obstruction does not seem to result from loose membrane above the tube, but extreme tumefaction of the epiglottis and aryteno-epiglottic folds does in rare cases give rise to dangerous constriction at this point, necessitating tracheotomy.

The tube is more liable to be expelled in the act of vomiting than by coughing. The larynx may be injured in attempting to remove the tube if the extractor be passed down beside instead of into the opening. It is important, therefore, to remember that no force whatever is required to remove the tube, and that any resistance to the withdrawal of the extractor proves that it is caught in the tissues on the outside.

In *feeding after intubation* the entrance of food into the trachea is

almost sure to be fatal. Liquid or semi-solid food may be given through an œsophageal tube or by enema. The best method is to allow the child to swallow it while his head is depressed and a little to one side.

Intubation may be employed to relieve dyspnœa or as a curative agent to effect dilatation in deformity of the interior of the larynx. In the adult it is applicable in a large variety of conditions of laryngeal stenosis, both acute and chronic, among which may be mentioned obstruction to the larynx or œdema glottidis from any cause; injury to the larynx from fracture, incised wounds, or internal violence, as from attempted endolaryngeal operation, foreign body, or the like. The chronic conditions in which it is indicated are such cases of stricture as may be amenable to treatment by the division of cicatricial bands and systematic dilatation. These include cicatricial contractions resulting from syphilis and other diseases attended with laryngeal ulceration, and from traumatisms and chronic thickening of the soft parts, in which the subglottic variety may sometimes be included. It is also useful in some cases of laryngeal neoplasm, in laryngeal paralysis threatening asphyxia, and in advanced tubercular laryngitis with obstruction. It may also be useful in fracture and other injuries of the laryngeal cartilages.

The insertion of the tube is less difficult in the adult than in the child. It should be done, if possible, with the aid of the laryngoscopic mirror, although this is not absolutely necessary.

In passing the tube the larynx should first be anæsthetized with cocaine. The patient should be seated as for the ordinary laryngoscopic examination, and the tube, aided by the mirror, should be introduced as in the infant, excepting that the finger of the operator is not used as a guide. Instead of this, as is customary in the passage of any endolaryngeal instrument, the aid of the patient is depended upon to open the larynx, either by the act of phonation or deep inspiration. The use of a mouth-gag in the adult is not required. Intubation in suitable chronic cases has practically superseded all older methods of dilatation. While the larynx tolerates the presence of the tube with great readiness, too long retention may injure it, and is not recommended. Such a case should of course be watched, and the tube removed and reinserted as often as required by cleanliness, the condition of the parts, or the necessity for more active dilatation through the insertion of a tube of larger diameter.

TUMORS OF THE LARYNX AND TRACHEA.

New growths of the larynx may affect it primarily or may extend to it from neighboring parts. They may be either benign or malignant. Distinction between the two varieties is sometimes extremely difficult. The so-called tubercular specific tumors which are occasionally seen in the larynx are not properly to be included in this class of affections, and should be considered elsewhere.

The ETIOLOGY of benign growths of the larynx is practically unknown. Although more common between thirty and fifty, they may be observed at any age, and one form of growth, papilloma of the larynx, may be congenital.

These tumors are more common in men than in women, and their most frequent location is upon the vocal bands.

Subglottic tumors are comparatively rare. Intraglottic growths usually spring from the free border of the anterior part of the vocal bands—those above the glottis from the epiglottis and from the aryteno-epiglottic folds, the subglottic from the inferior surface of the vocal bands. The benign tumors which may occur in the larynx, somewhat in order of frequency, are—1. Papillomata; 2. Fibromata; 3. Cystic; 4. Angeiomata; 5. Adenomata; 6. Myxomata; 7. Lipomata; 8. Chondromata. Although these growths occur in considerable variety, there are but few that are seen with any degree of frequency.

The SYMPTOMS of intralaryngeal growth will depend upon the location, the size, and the shape of the tumor, whether it is pedunculated or not, and, to some extent, upon the age and characteristics of the patient. The most commonly observed symptom is the alteration in the quality of the voice. This, at first hardly perceptible, becomes more and more marked, until finally complete aphonia may result. Especially is this the case with new growths situated upon the vocal bands. The change in position of a pedunculated growth may cause sudden and marked alteration in the symptoms, while a vascular growth, particularly in the early stages of its development, may demonstrate its presence or not in accordance with the state of activity of its circulation. Dyspnœa, generally wanting in the adult unless the growth should have attained considerable size, in the infant is commonly present and may be urgent. It is generally more severe at night than during the day, is accompanied by stridor, and is due to obstruction by the growth, the inflammatory conditions excited by it, and sometimes by the attendant spasm of the glottis. It may be so simple as to pass unnoticed, or so severe as to cause death from asphyxia, varying with the location of the growth. Cough in the adult is usually not marked, and is distinctly laryngeal in character. In the child it is a frequent symptom, and often severe. It is spasmodic, and is sometimes accompanied with hæmoptysis. There is rarely dysphagia or pain.

The only satisfactory means for studying these growths is by the use of the laryngoscope. The expectoration will seldom give evidence of their existence.

Their PROGRESS is usually slow, varying with the nature of the growth. Papillomata sometimes increase rapidly, especially where a growth has been irritated by attempts at removal, by intercurrent acute affections, or by over-use of the voice.

Their DURATION is, of course, variable, and they may recur after removal, especially papilloma and cyst.

The PROGNOSIS depends upon the nature of the new growth and upon the age and general condition of the patient. It is far more serious in the infant, on account of the difficulty of endolaryngeal operation, and also because in the child the papillomatous variety is the most common. Of all the varieties of growth, so-called diffuse papilloma is by far the most serious, on account of the difficulty in differentiating it from epithelioma. Recurrence is frequent in this, contrary to what is true in the case of other benign growths.

TREATMENT.—Laryngeal growths are probably less common now than formerly, by reason of the early and effective treatment of the subacute and chronic affections of the upper air-passages, and especially those of the nose. As to the actual treatment to be pursued in a given case, everything will depend upon the age and condition of the patient, the location, size, and shape of the growth, and, most important of all, upon its histological character.

The possibilities of the treatment of papilloma may be considered as follows: In infants, particularly where the growth is interfering with respiration, it should generally be removed as speedily as possible. Thyrotomy in many cases has given excellent results.

Danger from the growth of granulations may be avoided by the wearing of a tracheal cannula.

Whether a supposed papilloma is in reality a malignant growth or not, it should never be unduly irritated. If the tumor be pedunculated, circumscribed, and located conveniently, there are few objections to its removal by endolaryngeal operation. When, on the other hand, it is sessile, difficult to reach, or multiple, such attempts may give imperfect results or be followed by quick recurrence, and other methods may be indicated. Of these the one attended with the best results in the experience of the writer is the frequent daily application to the interior of the larynx of a spray of strong alcohol. Under this, persistently continued, growths of considerable size have entirely disappeared. Local rest is imperative. Complete cure has more than once followed tracheotomy.

In the employment of the endolaryngeal method the larynx is first cocainized, and while its interior is being demonstrated by the laryngo-

Fig. 79.
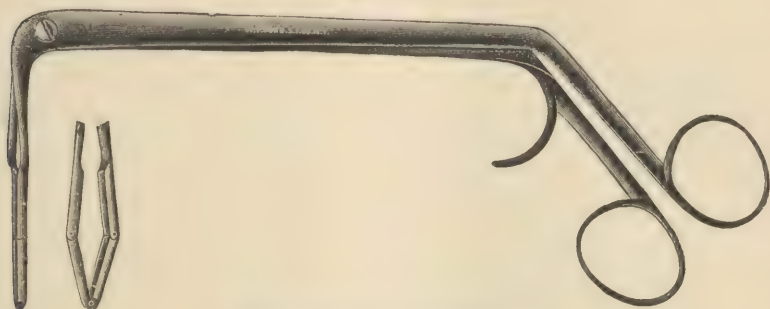
Dundas Grant's laryngeal forceps.

scope a suitable instrument is introduced into it, and the growth, or a fragment of it, seized and removed. Many different methods and instruments are used for this purpose. Among them may be mentioned evulsion by means of forceps (Mackenzie's, Grant's, Shroetter's, Krause's); crushing or " grattage " (Voltolini), by which such parts of the growth as are not removed are so injured that they either slough or are destroyed by the resulting inflammation ; incision with laryngeal knife or scissors; excision by means of specially constructed laryngeal instruments or by the cold-wire snare or the galvano-caustic loop; cauterization by means of the galvano-cautery or chemical caustics, such as chromic acid, nitrate of silver, and chloride of zinc.

MALIGNANT GROWTHS OF THE LARYNX.

Malignant disease of the larynx may be intrinsic or extrinsic, primary or secondary. It may be sarcomatous or carcinomatous. Epithelioma is by far the most common.

Laryngeal cancer most frequently attacks men at middle life. It may occur, however, in the young. Local irritations seem to favor its production. In its earlier stages it is generally unilateral.

Sarcoma commonly originates either from the true or from the false vocal bands, although it may spring from almost any part. The tumor

is usually rounded, and single or somewhat lobulated. Its surface may be either smooth or somewhat papillary or rugose. The color is generally red; sometimes, however, it is grayish-yellow, and in other cases of a darker color than the surrounding membrane. Often, especially when ulceration has taken place, it may be difficult to distinguish it from papilloma, and the diagnosis can only be established by microscopical examination. When the disease is making rapid progress and destroying and infiltrating the structures in its neighborhood, it is difficult to distinguish it from carcinoma. It is commonly of the spindle-celled variety.

The favorite points of departure for *epithelioma* of the larynx are the ventricular bands. It may arise, however, from one of the vocal bands, the epiglottis, the aryteno-epiglottic folds, or, indeed, from any part of the larynx. As the disease extends it becomes impossible to identify the point of origin. In general, it is apt to originate from parts which are subject to a certain amount of irritation. The appearance of the growth in its first stages is variable. It may occur as a small papillary tumor, as a rounded well-defined swelling, or as a diffused infiltration. The first variety is often impossible to differentiate from true papilloma. A valuable early diagnostic sign is the general infiltration of the muscles in the neighborhood of the growth, resulting in a marked corresponding loss of motion, as also is the tendency of epithelioma to advance from the middle of the larynx backward: in papilloma the opposite is true.

The microscopical demonstration of epithelioma will of course establish the DIAGNOSIS. Failure to find it, however, does not by any means exclude it.

In the later stages diagnosis is less difficult. The surface becomes ulcerated, covered with unhealthy granulations, and bathed in fetid pus; the surrounding mucous membrane is inflamed, and sometimes there is considerable submucous œdema. The cartilages are attacked, and sometimes those in its neighborhood become ossified, especially the upper tracheal rings in extensive epithelioma of the lower part of the larynx. Deformities of the exterior contour of the larynx appear, and as the disease progresses the neighboring parts outside the larynx become involved in a process of general destruction.

The TREATMENT OF MALIGNANT TUMORS OF THE LARYNX may be either palliative or curative. The *palliative* treatment may be either therapeutic or surgical. For the former, various topical applications may be made to the affected parts by means of solutions, sprays, powders, or vapors. Solutions are generally used in the form of atomized sprays, and are employed for purposes of cleansing or disinfection, to subdue pain, and to retard or overcome the progress of the growth: they may consist of antiseptics (Dobell's solution, listerine, boracic acid, and the like), anodynes (cocaine or morphine), or caustic medicaments. The comfort of the patient may be enhanced and much local and general irritation prevented by keeping the parts strictly cleansed and by great care in the matter of feeding. By the surgical palliative treatment dyspnœa may be relieved by intubation or tracheotomy, and obstructing fragments of the growth may be removed.

The *curative* treatment may be divided into three classes—namely, endolaryngeal operation, laryngo-fissure or thyrotomy, and laryngectomy or extirpation of the larynx.

Tumors of the trachea may be benign or malignant. The benign growths, often referred to as polyps, are generally either fibromata or papillomata. Submucous cysts, multiple enchondromata, and osteomata have been observed. In addition to these may be mentioned the various kinds of growth composed of granulation-tissue which develop after tracheotomy either during the time the cannula is in position or, as occasionally happens, in the cicatrix of the wound. The dyspnœa which they cause sometimes necessitates reopening the trachea for their removal and the reintroduction of the cannula.

The TREATMENT consists in the removal of the growths. This may occasionally be done through the natural passages, as described by Jarvis, or with the Grant forceps in cases where the growth occurs in the vicinity of the glottic aperture; otherwise, tracheotomy and removal by suitable means. In operating, the head of the patient should be low, in order that the blood may not gravitate into the bronchi.

LARYNGECTOMY.

In total excision the patient lies on the back with a pillow under the shoulders, the head being somewhat low. A preliminary tracheotomy is often performed and a tampon-cannula inserted. An incision is made in the median line from the hyoid bone to a point a little below the cricoid cartilage, and a transverse incision over the hyoid bone meets this at its upper end. On exposing the larynx the sterno-hyoid muscles are drawn to one side and severed close to their insertion. The soft parts are bluntly dissected from the larynx. Vessels are ligated as encountered. After the sides of the larynx become free the inferior constrictor of the pharynx is cut close to its insertion into the thyroid cartilage. The trachea is next cut across just below the cricoid, and drawn forward, while its lumen is well packed with sponges or iodoform gauze, after the insertion of a trachea tube of proper size and form. Where possible, preservation of the lower half of the cricoid will aid in the adaptation of the artificial larynx. The larynx is dissected from the deeper parts until the upper corners of the thyroid are freed. Finally, the thyro-hyoid membrane is cut across and the larynx removed. The epiglottis is removed or left in place according to its condition. If it is desirable to see the inside of the larynx before removing it, the thyroid can be split down the middle and the sides held apart, while the upper end of the trachea is packed with sponge or gauze. The organ can then be removed piecemeal.

The partial operation is usually performed by splitting the thyroid down the middle, packing the upper end of the trachea, and then removing as much of the larynx as is desirable.

After the operation the upper end of the trachea is packed firmly with gauze to prevent blood and saliva from flowing into it, and the rest of the wound stuffed lightly with an antiseptic gauze. Foreign material may be prevented from entering the lungs by elevating the foot of the bed. Nutritive enemata are given for the first forty-eight hours; then a stomach-tube may be passed through the wound into the œsophagus and gastric feeding begun. The packing is removed from

the wound as often as necessary, and the parts washed with a weak antiseptic solution.

If suited to the case, an artificial larynx may ultimately be inserted. The simplest and best of these is the one devised by Bond of London.

In a modification, practised with brilliant success by Cohen, the whole larynx is removed and the free end of the trachea fastened to the outside of the cervical wound. This secures complete removal of the growth, and subjects the patient to the minimum of risk of impairment of special function and usefulness of the part, of discomfort, and of outward deformity. The chief danger, aside from unskilful technique and accident occurring during operation, is that of septic infection or of septic pneumonia.

Injuries to the Epiglottis.

In a wound of the epiglottis the question is whether the injury can be spontaneously repaired or whether the removal of the lacerated or diseased portion may be desirable. Experience has proved it advisable, where necessary, to remove almost any portion of this member, patients who have suffered its entire loss being able to swallow, with the exercise of a little care, without difficulty. In certain conditions of disease—as, for instance, where the epiglottis has been so deformed by contraction as to obstruct the larynx, or where it is the seat of severe tubercular disease—the removal of the offending portion may be undertaken. This is sufficiently easy, and may be effected by the use of the galvanic cautery, snare, or by properly-curved cutting forceps. New growths of the epiglottis, when situated upon its anterior face, are often easy of removal, especially where the growth is not of a malignant character.

The Uvula and Soft Palate.

Malformations of the uvula include asymmetry, absence, congenital elongation, and the condition known as bifid or double uvula.

Congenital elongation of the uvula has been observed as hereditary. This condition, as well as elongation from simple relaxation, is easily remedied by the amputation of the redundant part.

Bifurcation, a result of arrested development, is quite common. To relieve the more pronounced cases the tips may be removed, and the inner aspect of each denuded well up to the base, and then brought together.

Amputation of the uvula is now practised with more discretion than formerly. The simplest and best instrument for its performance is a pair of long-handled scissors, one blade slightly hooked at its tip so that the uvula may not slip from its grasp. A holder, made on the principle of the thumb-forceps and about eight inches in length, possesses the advantages over other forceps that it has not the inconvenient scissors-handle, that it may be held firmly and with great steadiness by allowing its proximate end to rest in the hollow between the thumb and forefinger, the whole hand meanwhile being steadied by resting the fourth and fifth fingers against the patient's chin, and, finally, that in applying the scissors the forceps may be used as a guide.

In operating, the patient's tongue should be held down by himself or by an assistant with a tongue-depressor, and he should be instructed to breathe quietly, so that the throat may be relaxed and the pharyngeal region kept in a quiescent state. The amount necessary to be removed having been carefully estimated, the uvula, under cocaine anæsthesia, is grasped by the forceps at a point below the proposed line of incision and held carefully in position, care being taken to avoid stretching it, the result of which is to drag the mucous membrane so far downward that in removing it the parts beneath are denuded and the healing process thereby greatly retarded. The scissors, carefully guided by the hand and eye of the operator, are then applied and the separation of the redundant tissue is completed. The same result may be obtained by means of the Jarvis snare, in the use of which it is only necessary to seize the part to be removed in the loop of the écraseur without the aid of the forceps. This latter method is not painful if cocaine anæsthesia be employed, and it is sometimes convenient and effective. The amount of relief possible from this simple procedure is sometimes remarkable, the symptoms, local and reflex, vanishing quickly, the general health returning to a normal basis, and the voice gaining markedly in quality and power. In very rare instances hemorrhage, troublesome in its character, has resulted from this operation.

New Growths.—*Papillomatous growths*, generally of small size, but sometimes of sufficient dimensions to cause irritation, are occasionally seen upon the uvula near its free extremity, and may be either pedunculated or sessile. Myxomata and angeiomata may also occur.

Malignant growths of the uvula and soft palate are occasionally encountered, usually, however, as an extension of the disease from adjacent parts.

Syphilis, tuberculosis, lupus, and lepra of the velum and uvula are met with—the first often, the last three rarely.

Syphilis of the Velum Palati.—The occurrence of the primary lesion of syphilis, although now and then observed upon the tonsil, is, upon the velum, almost unknown.

The tertiary form of syphilis may occur in the soft palate at any period of time beyond two years after the primary infection. It is characterized by true ulceration or loss of tissue, and is the result of the degeneration of gummatous deposit.

The effects upon the velum palati of tertiary syphilis are often most disastrous. Two varieties of cases may be described : 1. Those in which simple ulceration has taken place at or near the margins of the velum, without material loss of substance, so that the adhesions are limited and the greater part of the velum itself is intact. In these the progress is good. 2. When the loss of substance has been considerable, and when the soft palate has become extensively adherent to the pharynx, relief becomes a matter of extreme difficulty, and in many cases is next to impossible by any known plan of treatment. Complete adhesion, although rare, is sometimes seen.

The results of extensive adhesion of the velum to the pharynx are most distressing, and may be summed up as follows : Mouth-breathing; impairment of the quality and tone of the voice ; interference with drainage from the nasal cavities and naso-pharynx ; consequent upon this, loss of hearing from irritation of the Eustachian tube and the almost inevitable occurrence of serious middle-ear disease ; loss of the sense of olfaction. When the passage to the lower part of the pharynx is contracted there are sometimes dysphagia and dyspnœa.

The TREATMENT of this condition consists in the attempt to separate the adherent tissues, and to establish, more or less perfectly, communication between the upper and lower pharynx. In operating, by cutting against the point of a sound passed through the nose into the upper pharynx and used as a guide, an entrance may generally be effected.

By skill, ingenuity, and unremitting patience much may be done to help the sufferer.

In general, however, the prognosis is very unsatisfactory. Operations must sometimes be done under anæsthesia, and the hemorrhage which not infrequently attends such attempts is sufficient to call for the use of a tampon-cannula. Secondary hemorrhage is also not uncommon.

CONGENITAL MALFORMATIONS OF THE PHARYNX.

Congenital malformations of the pharynx are of rare occurrence.

Of congenital malformations of the neck, the pharyngeal fistula is by far the most common. This is divided into two varieties, the complete and the incomplete. They are, as a rule, unilateral, and occur more commonly on the right side. They are usually incomplete. Their external opening is usually found upon the side of the neck, anywhere in the course of a line from the sterno-clavicular articulation to the angle of the jaw. Rarely they may open in the median line over the larynx or trachea. The internal opening is generally found in the lateral wall of the pharynx, behind the cornu of the hyoid bone and near the tonsil, or in the pharyngo-palatine arch. The canal varies in length and in diameter, is usually somewhat tortuous, and sometimes so much so as to be almost impassable to a probe. Its diameter is always greater than that of the external opening, and it can be much increased by retained secretions.

The DIAGNOSIS is from the history of the case, the position of the opening, and course of the canal as demonstrated by the probe. The existence of an internal opening may sometimes be found by probing or by injection through the canal of a colored liquid.

The TREATMENT is sometimes very difficult. It depends upon the destruction of the epithelium lining the canal by caustic injections, notably those of iodine; by direct cauterization with the galvano-cautery; or by the radical extirpation of the fistula throughout its entire extent. Operation is often difficult and dangerous.

RETROPHARYNGEAL ABSCESS.

Circumscribed abscesses of the pharynx are generally due to the breaking down of lymph-nodes. Their situation in the neighborhood of the pharynx causes them to manifest peculiar symptoms and to be attended with special dangers. Three varieties may be recognized— the retro-, the lateral, and the anterior pharyngeal.

Chronic abscess of the retropharynx is a common disease in the young. It is a serious condition, threatening as it does the life of the patient, but one which is, as a rule, entirely remediable by the prompt application of proper treatment.

Although almost invariably found in infants, it has occasionally been observed in adult life. A debilitated condition in general, chronic cachexia, and the influence of certain infectious diseases may all predispose to it.

A serious form of retropharyngeal abscess is sometimes found in persons suffering from caries of the cervical vertebræ.

The early SYMPTOMS are like those of ordinary pharyngitis. The pharyngeal inflammation, however, continues, and, instead of subsiding, the swelling continues to increase. The neighboring cervical lymph-nodes may be enlarged. The attack is sometimes sharp and well pronounced, and in other cases it is slower in its course; the symptoms are less conspicuous and the development of the condition is insidious, the progress of suppuration being very slow. The first variety is more common. Its onset is characterized by high fever, headache, and

vomiting, sometimes by chills and convulsions. The symptoms of the acute sore throat are more or less severe, with considerable pain in swallowing. Another prominent symptom is dysphonia. Pain is especially marked in the back of the throat and is increased by movements of the head.

The TREATMENT of retropharyngeal abscess in its early stages is similar to that of acute inflammatory conditions of the pharynx. Upon the earliest detection of pus, free incision should be made through the posterior wall of the pharynx into the abscess, the most prominent part of the swelling or that at which the fluctuation is most distinct of course being selected. In doing this the pharynx should be clearly demonstrated, full preparation made for the operation, and the instant the knife is withdrawn the patient, if an infant, should be inverted to prevent the escaping pus from entering the larynx. In the adult the patient's head may be caused to hang over the edge of a table. Anæsthesia is contraindicated.

Lateral abscess of the pharynx may closely resemble phlegmonous tonsillitis. It differs, however, from the latter disease in being caused by the suppuration of a lymph node. The symptoms are analogous to those of retropharyngeal abscess, excepting that dysphonia is less severe. Symptoms caused by irritation of the accessory or pneumogastric nerves may sometimes arise.

External inspection and palpation of the neck may demonstrate the presence of a localized swelling in the neighborhood of the angle of the jaw, while an inspection of the pharynx will show a condition hard to differentiate from acute tonsillitis.

This form of abscess is commonly acute, and is generally recovered from. Its proximity to the great vessels of the neck, and particularly the carotid, renders it a source of some danger to these organs.

Treatment.—Incision is not always possible through the wall of the pharynx, and in many cases it will prove easier to reach it from the outside. External incision has been highly recommended, because it is the best means of thorough evacuation and treatment of the cavity. Where pus has migrated into the muscular planes of the neck this treatment will of course be required. Hemorrhage from one of the great blood-vessels from erosion of its walls is almost necessarily fatal. Nevertheless, in such a case the common carotid has been successfully tied.

FOREIGN BODIES IN THE PHARYNX.

Small objects are apt to be lodged in the tonsil or entangled in the adenoid tissue at the base of the tongue. Larger substances will be more commonly found either in the glosso-epiglottic or the pyriform sinuses. The sensations and opinions of the patient as to the existence of a foreign body in the pharynx are unreliable, hyperæsthesia of the pharynx often simulating the latter condition.

Examination should be conducted by the aid of a strong light and cocaine anæsthesia. Irritability may be relieved by the swallowing of ice or very cold water. For direct inspection of the throat it is sometimes useful to assist the action of the tongue-depressor by pressing upward the thyroid cartilage, thus bringing the different parts into view. Failing to discover the object in this way, the laryngeal mirror should be used. The practice of digital examination of the throat, although valuable, should be made a last resort, on account of the reflex irritation which it excites.

A small object in the tonsil may easily escape detection. It is always well to sweep a probe gently over the surface of the gland, and to examine with a rhinoscopic mirror behind the palatal folds. The extraction of one object does not preclude the possibility of others remaining.

The TREATMENT depends upon the immediate extraction of the offending subject, with means at hand for the proper demonstration of the throat and suitable curved forceps to accomplish removal. Where the body is lodged very low in the pharynx and is of a shape which renders its extraction through the natural passages impossible, entrance to the pharynx from the outside may be demanded. The continued presence of an irritating body in the throat may give rise not only to dangerous local symptoms, but to cough and local irritation of a distressing character, causing the general condition of the patient to rapidly deteriorate.

LYMPHOID HYPERTROPHY AT THE VAULT OF THE PHARYNX.

Lymphoid hypertrophy at the vault of the pharynx is a condition of chronic enlargement of the tissue at the vault of the retronasal space, otherwise known as Luschka's tonsil, the pharyngeal, or the third tonsil. As commonly met with, it is of two varieties. In the first the lymphoid element may be associated with more or less fibrous tissue; in the second the latter is but feebly represented. The size of the growth may be so great as to practically fill the retronasal space, or, on the other hand, it may be so small as to make it difficult to determine whether or not its condition is pathological. It may be confined strictly to the vault, or be diffused over the posterior and lateral walls of the pharynx, or it may exist upon the posterior wall of the pharynx alone, either in a large well-aggregated, tumor-like mass or in more or less thickly scattered elevations.

FIG. 80.

Position of adenoid enlargement as commonly located in the upper pharynx.

Its SYMPTOMS are, first, those due to mouth-breathing—namely, a dull, stupid expression of the face, anæmia, drooping of the eyelids, open mouth, projecting teeth, arched palate, pinched nostrils, and the deformity of the chest known as "pigeon breast." Again, there is mental dulness, loss of hearing, nasal obstruction with all the distressing symptoms of which it is the cause, defective speech, and, generally, almost constant catarrh, the secretions from which are swallowed, with the result of producing indigestion. The occurrence of reflex effects is shown in frequent headache, irritative cough, laryngeal spasm, and other neurotic symptoms, including in some exceptional cases such extreme results as chorea and, it is said, epilepsy. Even in the infant it may be suspected through the presence of mouth-breathing, snoring, and a marked inability to perform the act of nursing.

One effect of the obstruction to nasal respiration is the permanent deformity of the bony framework of the nose and hard palate which generally accompanies it.

Considering these things, it becomes important to secure the early recognition of the necessity for TREATMENT in such cases, and to see that it is promptly and efficiently carried out. This must depend in some degree upon the nature of the growth, the size to which it has attained, and upon the age of the patient.

In a few instances, where the disease is acute or subacute, where the tissue is soft, and the amount of growth small, the application of resorptives and the administration of alterative and tonic medicines, together with careful attention to hygiene, may possibly accomplish a cure. Almost invariably however, these means will be found unsatisfactory. In the surgical treatment of this condition by far the most effective method is its forcible removal by means of some surgical operation.

For removal by operation many instruments have been devised. These may be divided into four classes : *a*, those made upon the principle of the curette ; *b*, the double curette or forceps ; *c*, the wire loop ; and, finally, *d*, the adenomatome. The first class includes the ring-knife of Dr. Meyer and its modifications and the sharpened finger-nail of the operator, a useful adjunct to the more complicated instruments ; the second, the forceps of Loewenberg and its varieties ; the third, a modification of the Jarvis snare ; and, finally, the fourth, a double cutting instrument, furnished with scissor blades, called the adenomatome. Of these instruments, the most generally useful are a modified Loewenberg forceps and the sharp curette.

The other instruments necessary for operating under anæsthesia are a good mouth-gag and a soft-palate retractor. The latter should be made with a shank broad enough to protect the uvula from injury during the process of operation.

The position of the patient during operation is of considerable importance. Two methods, performed under complete ether or chloroform anæsthesia, are in common practice : In the first, applicable mainly to infants, the child is held upon the lap of an assistant in the sitting posture, with the head upright and turned toward a good light. The head is steadied by a second assistant, who also manages the mouth-gag and administers the anæsthetic. The soft palate may be drawn upward and forward by means of the palate-retractor or White's palate-hook, or it may be secured by tapes passed inward through the nose and outward through the mouth, the ends being tied outside after Wales' method. With the head inclined forward in this position the blood caused by the operation will tend to escape from the mouth, instead of being swallowed. Moreover, the pharynx can be well illuminated and the steps of the operation better directed by the aid of vision. The position upon the back is preferred by many good operators, requiring as it does the services of but one assistant, and being the one to which a large majority of surgeons are better accustomed. It is not so favorable as regards the admission of light to the pharynx, and therefore it requires a greater degree of skill on the part of the operator, whose tactile sense must be highly educated by way of substitute. The blood, instead of flowing from the mouth, is swallowed into the stomach. This is not a disadvantage, for it trickles down from the posterior wall of the pharynx and escapes into the œsophagus almost without making its presence felt, unless the flow excited has been considerable.

A possible objection to the upright position is the additional risk of fragments of detached tissue falling into the larynx and thus causing asphyxia. Such accidents have been reported, having occurred in the

Gottstein's curette.

course of the use of the Gottstein curette. This would not be possible under the use of the forceps.

The management of the palate-retractor should be entrusted to a skilled assistant, as upon this the convenience, and to some extent the success, of the operation will depend.

Removal by curette or forceps is sometimes practised without anæsthesia. While it may be called for in some cases, it is apt to be exceedingly painful, and far less thorough than by the method just described.

The operation is attended with more or less bleeding, generally of no importance, but sometimes considerable. It is best, therefore, that the tissue be torn away rather than cut. This method has the additional advantage of greater thoroughness, as masses of adenoid much larger than the fragment grasped by the instrument are frequently separated, and by this method it is not likely that the healthy and more resisting parts will be injured. Remnants left by the forceps may be removed by the finger-nail, by Hooper's forceps, or by means of a small carefully-guided curette. Should the removal of a mass of adenoid be followed by undue bleeding, it is well to defer further attempts at operation for a few moments until the hemorrhage shall have ceased, or, at least, until it shall have sufficiently diminished. Too great force in the separation of a fragment of tissue must be avoided. It is better to release the mass included in the grasp of the forceps and seize a smaller portion, or else, by applying them in a somewhat different position to separate adherent fragments, than it is to attempt to accomplish too much at once. As large masses of hypertrophied tissue often exist upon the posterior wall of the pharynx as well as upon the vault, it is necessary to secure the removal of these with the rest. The corners of the upper pharynx also, immediately above the Eustachian prominences, must be carefully cleared.

In operating upon the upper pharynx general anæsthesia is of the greatest possible value both to the physician and to the patient. With it ample time is afforded for careful examination and for the checking of undue bleeding should any occur; perfect control of the operation, as well as of the patient, can be maintained; absolute relaxation of the throat can be secured; the inducement of retching from pharyngeal irritation, that most active and persistent of reflexes, can be avoided; troublesome remnants of the growth can be recognized and removed; undue excitement can be prevented; and finally, the whole work can be accomplished without the knowledge on the part of the patient of what has been done.

Following operation, the general condition should be made as perfect as possible, change of air often being beneficial, and the patient should be carefully examined in order to determine whether or not the operation has resulted in a thorough and complete success. Should the contrary prove to be the case, further treatment may be called for, and although, when properly performed at first, it will seldom be necessary to repeat the operation, there is no reason why this should not be done when required. Indeed, it is well in difficult cases to mention to the parents beforehand the existence of such a possibility, especially in dealing with very young patients.

NASOPHARYNGEAL TUMORS.

This variety of growth, fortunately, is of rare occurrence. It origi-

nates usually about the time of puberty, tending to subside after the patient is of age, and is most common in males.

The ETIOLOGY is unknown. The tumors generally arise from the basilar process of the occipital bone and the base of the body of the sphenoid, whence they may extend to almost any part of the pharynx, the nose, or its adjacent sinuses. The development of the growth is active up to the twentieth year. After this, however, it ceases to grow, and by degrees will atrophy and practically disappear. While not highly malignant in itself, it is exceedingly dangerous from the destruction to surrounding parts which attends its progress. Inspection shows that the surface of the tumor is smooth, even, and rounded, and numerous large vessels may appear upon it; its color varies from a pale pink to a deep, congested reddish color. In the nasal fossa the growth appears dark red in color, dense in structure, firmly attached, and easily made to bleed. The membrana tympani are of course depressed, owing to the interference with nasal respiration.

TREATMENT.—While its base is still absolutely limited to the pharynx, operation through the natural passages is clearly and unmistakably indicated. For this purpose the écraseur, either in the form of the galvano-caustic loop or the cold snare, has been found decidedly the most practical. In the employment of the electric loop the best method is, if possible, to surround the base of the growth with the galvanic écraseur, passed either through the nose or through the mouth. The inclusion of the growth within the loop is often difficult. Much easier manipulation is made possible by the use of a separable double cannula, through which the wire may be passed. The curved cannula, carried behind the palate, is inferior to that used through the nose. The loop, aided by the finger in the pharynx, should be fixed to the highest possible point.

The above directions relating to the cold snare will apply as well to the incandescent loop, which is in some respects superior. With the latter the density of the growth may be more readily overcome, resulting in the destruction of some of the remaining tissues, and the danger of hemorrhage almost entirely done away with. Only a moderate degree of heat should be applied. Attempts to tear the growths away piecemeal will be likely to cause serious hemorrhage, and are absolutely contraindicated.

Excision without preliminary operation is, from the danger of hemorrhage, unjustifiable.

Ligation is sometimes useful. The use of the galvano-cautery, both in the form of the loop and for the destruction of remnants or of points of recurrence, makes it possible to thoroughly eradicate fibromatous growths. The electrolytic method is sometimes of great value.

Great aid is afforded the surgeon in these manipulations by the invariable enlargement of the pharyngeal space which is present.

When the growth has advanced beyond the vault of the pharynx and removal by the natural passages is impossible, the old method of removal after a preliminary operation must be discussed. While such radical procedures have now and then succeeded, the general statement may be made that they are far inferior in safety and success to early operation with the loop. Three varieties of procedure have been

employed—namely, operation carried on through the nose, through the mouth, or through an entrance effected by operations more or less formidable upon the superior maxillary bone.

Fibro-mucous Polypi.—These are composed of a mixture of the structural elements of the tissue from which they originate. They vary from a tumor of small size to one sufficient to fill the upper pharynx, and are generally smooth, dark red, and ovoid in form. They are probably more common than true fibromata.

The SYMPTOMS to which they give rise are principally those of nasal obstruction. They are otherwise harmless to the surrounding structures, and are not prone to bleed. They show little tendency to recur when removed, and may be extirpated by evulsion, or, better still, by the cold- or the hot-wire loop.

Enchondroma.—Enchondroma of the nasopharynx is extremely rare.

Malignant Tumors.—Malignant tumors of the nasopharynx, although rare, are really less uncommon than has been supposed.

The SYMPTOMS are similar to those of fibromata, but to these are added in certain cases severe pain of a lancinating character, which is apt to be referred to the ear and to be worse at night, severe dysphagia, and general cachexia. Sarcomatous tumors may be pedunculated, while sometimes they are more or less distinctly lobulated. They present no special features to the eye or to the touch by which their true nature can be detected.

The latter can be established by the aid of the microscope.

The PROGNOSIS is absolutely bad. The progress of development is rapid, and recurrence after removal is almost certain.

The best plan of TREATMENT consists in early recognition of the growth and its removal by the galvano-cautery or by electrolysis, any sign of recurrence being attacked at once.

Epithelioma.—Carcinoma of the pharynx is rare. In such cases the comfort of the patient may be enhanced and the progress of the disease retarded by the repeated thorough removal of the soft, fungating masses which fill the upper pharynx.

Dermoid Tumors.—These rare abnormalities are undoubtedly congenital.

CHRONIC HYPERTROPHY OF THE TONSILS.

Chronic enlargement of the tonsils consists in an abnormal increase of the lymphoid tissue of the organ, sometimes accompanied with a proliferation of its fibrous stroma. The latter is apt to occur where the disease is of long standing, although not uncommon in the young. The hypertrophic process is most active at the age of puberty, after which time it tends to decline until beyond thirty the disease is more uncommon. It may originate, however, at almost any time before adult life. It has been present in old age.

The SYMPTOMS are usually plain and easily recognized, and are in many particulars similar to those which accompany the local obstruction and irritation found with lymphoid hypertrophy at the vault of the pharynx. In some cases the tonsils are chronically inflamed, without being materially enlarged, the condition giving rise to annoying symp-

toms. These cases may be much relieved by the application of astringents to the crypts, or, still better, by the opening up or cauterization of such of the latter as are either dilated or inflamed.

Tonsillotomy.—Of the methods for removing the tonsil most commonly used, may be mentioned cauterization by chemical or electrical escharotics; écrasement, by means of the galvano-caustic loop or of the cold wire; abscission, by means of some modification of the knife or scissors. Both ligation and the injection into its substance of various supposed absorbents only need be mentioned to be condemned. The practice of enucleating the tonsil with the finger has lately been revived in some quarters. Excepting in young children it is of questionable value.

During the operation the patient should sit facing a good light, the operator with his back to it. By those familiar with the use of the head-mirror the latter, however, will generally be preferred. The patient, if an adult, should sit upright and well back in the chair, the head fixed against a properly-adjusted head-rest or supported by an assistant. The latter should stand directly behind the chair, and, while holding the head with both hands, should place the fingers of each hand over the tonsillar region of the corresponding side—that is, immediately below the angle of the jaw. Thus the tonsils may be prevented from receding before the pressure of the tonsillotome when it is introduced, and the operation may be performed with greater accuracy and thoroughness.

Having engaged the tonsil in the ring of the instrument, push the blade firmly and steadily through the included tissue, separate the fragment of tonsil, and, withdrawing the instrument quickly, remove the excised gland adhering to it, and at once, and before the patient realizes that there is to be a second operation, before bleeding sets in, and without giving opportunity to cough or clear the throat, excise the remaining gland. Thus both may be removed at one sitting, so that but one convalescence is to be endured: few young patients will submit to a repetition of the operation. The Physick tonsillotome has been modified, so that the handle may be reversed, enabling it to be used first in one hand and then in the other. Ambidexterity in the use of the one instrument is far better. The operation may generally be done very quickly.

As a rule, anæsthetics are not indicated in tonsillotomy. Cocaine anæsthesia is often effective, although, if the child is highly sensitive, irritable, or feeble, chloroform or nitrous oxide may be desirable. The introduction of the instrument into the pharynx is often more complained of than the actual separation of the tonsil.

Bleeding after operation is usually slight, and soon ceases spontaneously; if not, it may generally be checked by simple means, such as direct application to the cut surfaces of a mixture of one part gallic and three parts tannic acid, slightly reduced with water and applied upon a pledget of cotton. The sucking of cracked ice is also effective. Sometimes, however, hemorrhage may be severe, and, while fatal results have very rarely occurred, there are several cases on record in which this accident has taken place. With regard to this question, it may be said that moderate hemorrhage requiring direct pressure or astringents to check it is not very unusual: a severe hemorrhage occasionally occurs, and in view of the enormous number of tonsillotomies done the proportion of serious results has been exceedingly small. The source of the bleeding may be either arterial, from the division of one or two comparatively large arterial branches, or from the division of a large number of small arterial twigs; venous, from the division of the small plexus of veins which lie outside and below the tonsil; and capillary or general,

from the presence of the hemorrhagic diathesis. The records show that hemorrhage has very rarely occurred before the eighteenth year. This may be explained by the presence of the larger amounts of fibrous tissue in the adult tonsil. Park has discovered a new styptic of extraordinary efficiency, easily made by mixing fairly strong (25 per cent.) watery solution of antipyrine and alcoholic solution of tannin. A most tenacious, gummy mass is thrown down, which when applied on cotton or sponge with a little pressure will check all oozing.

FOREIGN BODIES IN THE TONSIL.

Foreign bodies may develop spontaneously in the tonsillar crypts through retention of the secretions of the latter. The presence of such a cheesy mass may give rise to much irritation. The condition should be relieved by removal of the deposit and free opening of the crypt. In rare instances a true calculus of the tonsil has been found. The presence of a tonsillar calculus may be determined by the discharge of fragments of the calculus, by inspection, a part of the mass being visible, or by examination with the finger or probe. Their removal may be accomplished either by enlarging the mouth of the crypt and extracting them or by excision of the tonsil. Their presence may pass unnoticed, not only by the patient, but by the physician, the symptoms often being obscure.

TUMORS OF THE TONSILS.

Tumors of the tonsils requiring radical operation are usually malignant, and are either epitheliomatous or sarcomatous. The latter are generally of the round-celled variety. The rapidity of their growth, their tendency to recur, the readiness with which the neighboring lymphatic nodes become infiltrated, and, finally, the important anatomical position of the tonsil, all militate against the success of efforts made to remove them. Operation may prolong life and give a certain measure of relief, however, and in some cases at least it has effected a cure. It should never be attempted without the clearest possible understanding, not only of the normal regional anatomy of the vicinity, but, in particular, of the important arterial trunks near by and their possible anomalies. Tumors of the tonsils may be removed through the mouth or through incision in the neck and into the pharynx. The latter method is called pharyngotomy.

Operation through the Mouth.—In cases where the tumor is well defined and projecting, as in the case of some sarcomata, and, now and then, of epitheliomata which have developed in an already enlarged tonsil, removal may be successfully accomplished by means of the galvano-caustic loop or even with the cold-wire écraseur, and such diseased tissue as remains subsequently taken away by any suitable method which may recommend itself. Even in this operation a preliminary tracheotomy is sometimes necessary. This method is less dangerous, and its results are as good as those of the more severe operations.

From the depth and obscurity of the parts a good light is indispensable. The writer has employed with great satisfaction a small incandescent electric lamp, which, introduced into the deepest recesses of the pharynx, demonstrates clearly the various parts under observation, thus enabling the surgeon to distinguish between affected and healthy tissues and to locate accurately any bleeding point. Such a lamp, of from one-

to three-candle-power, should, if possible, be provided in case its use be required.

The three principal operations known as pharyngotomy for the removal, from without, of malignant tonsillar disease are Cheever's, Czerny's, and Mikulicz's.

Tumors and Polyps of the Nasal Cavities.

The form of tumor known as simple mucous polyp, naso-fibroma, or, incorrectly perhaps, nasal myxoma, is by far the most common form of neoplasm found in this region.

The ETIOLOGY of these growths is obscure. Their duration is often difficult to determine.

The SYMPTOMS are, in general, those of obstruction to breathing, loss of the olfactory sense, local irritation, and persistent catarrh. They are usually referred to a time at which the patient became especially susceptible to acute coryza: the symptoms have grown progressively more annoying, and they finally reach a state where they are incessant. When located comparatively high or confined to one side, the patient may be unaware of their presence. On the other hand, the growths may actually protrude from the vestibule of the nose. As nasal obstruction becomes more pronounced the symptoms and the general discomfort become more severe. Mouth-breathing, snoring, and fatigue upon comparatively slight exertion are usually present. Reflex symptoms are not uncommon, such as headache, oftentimes severe, neuralgia in different localities and especially through the distribution of the facial nerve, reflex cough, and, finally, marked asthmatic attacks and neurasthenia. The eye may suffer from irritation of the conjunctiva and lachrymation and from various more or less obscure disturbances of vision. The auditory apparatus may also be seriously affected, owing to the obstructed nasal respiration, the catarrhal inflammation, and the possible reflex irritations which the polyps may excite. Vertigo, impairment of memory, mental hebetude, and insomnia are more or less commonly observed. The symptoms of coryza may vary from a tendency to sneezing and to the appearance of a watery discharge, apparently from slight exposure to cold, to catarrhal symptoms of the most pronounced and inveterate character and with excessive secretion. Pronunciation is affected, and the tone-quality and carrying power of the voice greatly impaired. The peculiar inability to fix the attention in these cases is called *aprosexia*.

The TREATMENT of nasal polyps should be first, thorough removal, and, second, prevention of recurrence. For the former various means have been employed from an early period, some of which are still in use. External applications to the growth are generally ineffective. Rarely, astringents may retard development and add to the comfort of the patient. The means most commonly employed, however, are those by which the growth is removed with forceps, separated by means of a wire snare, or destroyed by the galvanic cautery or ring knife. In order to operate intelligently and successfully the nasal cavity, under cocaine anæsthesia, should first be demonstrated by anterior rhinoscopy, the removal of as many polyps as possible effected, and, when sufficient

hemorrhage has occurred to obscure the parts, further operation deferred until another sitting. Variously constructed forceps are used for this operation, and for the removal of certain varieties there is no better method. In general, alligator forceps, the jaws of which should be serrated and not too large, will be found the most convenient. The most generally useful and least painful instrument for the removal of polyps is the Jarvis snare. For the removal of small growths situated

Fig. 82.

Jarvis snare.

high in the nasal cavity a finer quality of piano wire than that commonly employed is desirable.

The removal of cystic growths is often difficult from their great size. Incision into the wall of the tumor will, if it be a cyst, cause it to collapse, when it can be removed with ease. The galvano-caustic loop for the removal of simple nasal polyp is seldom necessary. A fine ring knife is sometimes useful for the removal of growths which are hard to reach by other means.

Little immediate treatment is needed after operation beyond protecting the sensitive membrane from the too free access of the air, especially in bad weather, and the keeping of the parts properly cleansed and disinfected. The necessity for aseptic instruments is emphasized by the fact that dangerous pyæmic symptoms have followed the careless removal of a simple mucous polyp.

For the prevention of recurrence the growths must not only be removed, but the localities from which they have originated must be absolutely freed from all trace of their presence. Either at the time of removal or subsequently applications of the galvano-cautery or other caustic should be made for this purpose. The nasal cavities should be treated locally meanwhile with alkaline and antiseptic sprays and, if necessary, with astringent solutions. Removal of the anterior extremity of the middle turbinated for access to the region which it covers may sometimes be required for the extirpation of polyps, but should be practised with great caution.

In the rare event of polyp appearing in the course of an atrophic rhinitis, its presence may act as a stimulus to secretion, and thus prove helpful.

INSECTS AND FOREIGN BODIES IN THE NOSE.

The impaction of a foreign body in the nose is a common accident. The entrance of living organisms, on the other hand, is somewhat rare in temperate latitudes, but sufficiently common in tropical and subtropical countries. While the former seldom gives rise to severe symptoms, the latter may readily prove fatal.

Foreign bodies are most apt to lodge in the widest part of the canal. Any object sufficiently small and capable of locomotion, such as an insect, may find its way into one of the adjacent sinuses. A foreign body

may give rise to great irritation, as may also attempts made to extract it.

The variety of foreign bodies which have been found in the nose is very great. The list comprises extraneous substances introduced either by accident or design by infants or insane adults; sequestra of diseased bone; and parasites.

The HISTORY is usually as follows: A child of about two years of age unobserved thrusts some small rounded object into its nostril. Soon symptoms of unilateral chronic inflammation are established, the irritation often being severe and the discharge extremely fetid. The body, if too firmly impacted to be dislodged by simply blowing the nose, remains fixed until removed by the surgeon. Not infrequently the presence of a foreign body passes unsuspected for many years, and the child is treated indefinitely for simple catarrh.

TREATMENT.—Preparatory to removing a foreign body first cleanse the mucous membrane anterior to it. Then thoroughly anæsthetize the membrane with a 6 per cent. solution of cocaine. The passage thus having been widened, the body may often be extruded by simply blowing the nose. Should it still be so firmly impacted as to require the use of an instrument, its removal will be greatly facilitated by the anæsthesia of the parts as well as by the additional space provided. A probe or small forceps will often answer the purpose of extraction. If necessary, the body may be first crushed. The copious hemorrhage which commonly results from the old method of extraction is not likely to follow after the use of cocaine, for the reason that less injury is done to the parts.

In all cases of fetid catarrh, particularly when confined to one side and dating back to infancy, careful examination with speculum and probe should be made, the nostril having first been thoroughly cleansed by means of a warm douche and the presence of a foreign body excluded before a positive diagnosis is made.

DIAGNOSIS is generally easy. In some cases, especially of long standing, the foreign body may be completely concealed by the secretions of the nose or by a mass of granulations. In the latter case the appearances have often been mistaken for syphilis, malignant disease, or lupus. Examination with a probe will at once determine the nature of the trouble.

After removal of the object the nostril should be washed several times a day with a weak disinfectant. Cure quickly follows.

The so-called rhinoliths, or nasal calculi, are concretions formed of the earthy salts of the nasal secretions. Sequestra of bone, particularly in tertiary syphilis, sometimes remain in the nasal cavity after their separation, thus acting as foreign bodies.

Fungi and Parasites.—Various fungi, as well as ascarides, leeches, centipedes, and earwigs, have found their way into the nasal cavities. The symptoms commonly present after such an accident are epistaxis, sneezing, headache, lachrymation, nasal discharge, and stenosis.

In the tropics, seldom elsewhere, various kinds of flies may enter the nasal chambers, preferably of a patient suffering from catarrh, and there deposit their eggs. These are quickly hatched, causing in succession irritability, tickling, and sneezing; later, formication, bloody discharges, and epistaxis, with redness of the face, eyelids, and palate; excruciating pain, generally frontal, insomnia, and, if the

condition continue unrelieved, necrosis of the parts, convulsions, coma, and death. Sometimes the larvæ are sneezed out, or they may be seen on examination of the nose, which of course will establish the diagnosis. The destruction caused by them may extend to the mucous membrane, the cartilages, and even to the bones of the head, the ethmoid, sphenoid, and palate bones having been found carious. The extension of the destructive process is often very rapid.

TREATMENT should be prompt and efficacious, and should be selected somewhat with reference to the stage of development of the larvæ and the progress which the condition has attained. If the case can be seen before the larvæ have migrated too far or have buried themselves too deeply, it is possible to cause their immediate and thorough expulsion by local cleansing, cocaine anæsthesia, and the inhalation of chloroform or of ether, the effect of the last-named drugs being to cause the insects to voluntarily vacate the nose. Insufflations of calomel and injections or infusions of tobacco, of turpentine, and of alcohol have been recommended. Of these, the two former seem to have given the best results. As failure to obtain relief is fatal, the propriety of surgical operation in extreme cases is worthy of consideration.

RHINOSCLEROMA.

This rare condition involves both the integument and the mucous membrane of the nose, whence it extends indefinitely. The disease appears in the form of well-defined tubercles, rounded prominences, or flat structures of considerable density, which begin upon the alæ and adjacent parts of the lips. The tubercles may be of the color of the skin or else of a brownish red, shiny upon the surface, devoid of hair, and traversed by dilated blood-vessels. Rigidity of the affected parts becomes apparent in consequence of the infiltration.

Pathologically, the growth seems to resemble round-celled sarcoma, although differing from it by the presence of certain small hyaline bodies of highly refracting power which seem to form its characteristic element. The latest investigations seem to demonstrate that certain microbes are an evident factor in its propagation. The fact that it is infectious has been proved by successful inoculation of the cultures of these microorganisms. (*Vide* p. 217, as well as Vol. I. p. 76.)

The disease must be differentiated from syphilis by the failure of constitutional treatment; from epithelioma by the appearance of the ulceration; from keloid in that microscopically the latter is composed entirely of fibrous tissue.

The only known TREATMENT is excision.

EPISTAXIS.

Epistaxis, or hemorrhage from the nasal cavities proper and their accessory sinuses, may be either active or passive. It may occur from violence, from some remote pathological condition, or as a vicarious phenomenon. The former is the most common. The bleeding may come from one nostril alone or from both. It may originate in the deeper part of one nasal cavity, and, owing to some stoppage on that side, be deflected into the nasal cavity of the opposite side, and emerge through that nostril or into the pharynx. Hemorrhage occurring during sleep, and the patient in such a position that the blood gravitates into the pharynx, might easily escape detection until serious loss of blood had resulted. Changing the position of the patient and causing him to clear his throat would probably demonstrate the presence of the bleeding.

TREATMENT.—Before attempting to treat epistaxis it is necessary to determine, as far as possible, its precise origin and cause. Vicarious hemorrhages and those occurring at the critical period of certain fevers may be allowed to continue unless excessive. With the plethoric also, and especially where it appears instead of menstruation, it should not be hastily interfered with. To stop the flow simple means will generally prove effective, such as absolute rest, the supine position, avoidance of allowing the head to hang forward, and standing with the head erect and the arms raised above it. The application of cold to the nose and the insufflation of cold water are effective, while the injection of water as warm as can be borne is an excellent styptic. Whenever possible direct applications should be made to the bleeding point, the latter having been carefully dried, with absorbent cotton, of nitrate of silver, of chromic acid, or of the galvanic cautery. Various astringents, such as alum and tannin, may also be used directly upon the bleeding point.

The injection of a solution of antipyrine, from ten to twenty grains to the ounce, has been found effective. If necessary, control of the hemorrhage may be gained by plugging the parts in the neighborhood of the bleeding. Anteriorly, this may easily be accomplished by packing against the bleeding surface a tampon of absorbent cotton, or, still better, one composed of a narrow strip of surgical gauze upon which some styptic—as, for instance, tannin—has been sprinkled. Park has

FIG. 83.
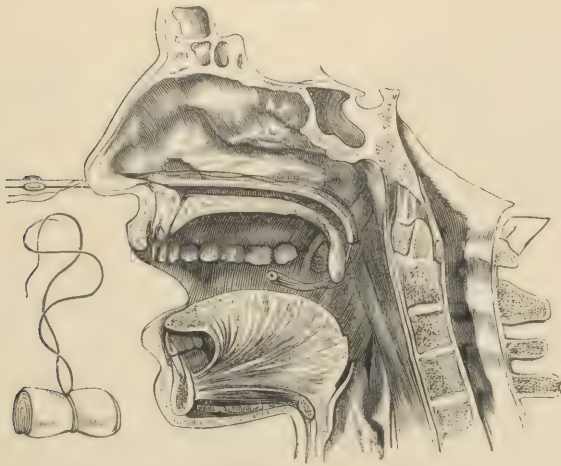
Plugging the nares with Bellocq's cannula (Fergusson).

recommended most highly the combination of solutions of tannin and antipyrine (each of 10 per cent.), by whose union a most tenacious and powerfully styptic substance is formed. This may be applied directly. Occurring posteriorly, the bleeding may be checked by inserting a tampon in the nasopharynx, and, if necessary, at the same time packing the anterior part of the nasal canal. For this a flexible catheter or *Bellocq's cannula* is used.

The latter consists of a cannula curved at one end, through which is passed a curved steel spring, the end of which is protected by means of a perforated ball. In order to

use the Bellocq cannula a loop of silk should be threaded through the eye in the end of the cannula. The steel should be drawn backward into the cavity of the cannula before the introduction of the latter into the nasal canal. To introduce the cannula pass the extremity with the silk loop through the nostril and backward along the floor of the nose to the posterior wall of the pharynx. Having reached the latter, thrust the steel spring forward, so that it shall emerge from the cannula and appear beneath the soft palate. A tampon of cotton, lint, or sponge, saturated with vaseline, should have previously been prepared and attached to the middle of a stout piece of soft woven silk, the latter about eighteen inches long. One end of this silk should now be securely tied to the loop of silk in the eyelet of the cannula, and with the aid of the latter, assisted by the finger placed in the pharynx, the string should be drawn forward through the nasal cavity until the tampon arrives in the lower pharynx. Here, by means of gentle traction made upon the string, combined with careful pressure upward from the finger, the tampon should be forced into the upper pharynx as desired. The tampon having been duly placed, it is well to make a firm block of absorbent cotton, around which the anterior nasal end of the string may be wound and held in the vestibule of the nose. The pharyngeal end of the string should be conducted out of the mouth and loosely attached to the patient's ear. In removing the tampon there is considerable danger that the parts may be irritated and thus the bleeding again provoked. It should never be drawn forcibly from the pharynx. The best plan, as a rule, is to first cleanse the parts as thoroughly as possible, and then apply a weak solution of cocaine in order to cause as much contraction of them as possible. While it may be considered in some cases necessary to do so, it is not desirable to allow the tampon to remain in the pharynx for more than twenty-four hours.

Severe bleeding may require the use of revulsives intended to cause reflex contraction of the nasal blood-vessels, the administration of remedies intended to quiet the action of the heart, the application of pressure internally as well as externally, and, in extreme cases, transfusion or some kindred measure.

THE ACCESSORY SINUSES.

The sinuses adjacent to the nasal cavities, and communicating with them, are four in number—namely, the *frontal*, the *ethmoidal*, the *maxillary* or *antrum of Highmore*, and the *sphenoidal*. It may be said of them all that they are located in regions of great anatomical importance, that the diseases to which they are subject are of an unusually serious character, and that the treatment which the latter may require for their relief is such as to demand the highest degree of special skill.

The *accessory sinuses* may be the seat of *hyperæmic* and of *infective* processes. The first condition generally complicates an attack of acute rhinitis, and may be difficult to distinguish from the latter except for the localized pain which it may occasion. *Suppurative disease* of these parts is an affection of much greater importance, the symptoms being more severe and the results more serious. The most important of the latter is the development of various abnormal conditions of the soft tissues lining the cavities, and of caries or necrosis of the bony structures underlying them. These diseases may develop from simple acute catarrh, from chronic rhinitis, or, in exceptional instances, from traumatic causes. In the maxillary sinus disease is often due to dental irritation. Local destructive processes accompanying syphilis or tuberculosis may possibly give rise to them.

The exciting CAUSE of the trouble is usually a lack of free drainage of the sinus through its natural opening. The chief causes may be regarded as occlusion, followed by acute, and later by chronic, suppuration. The inflammatory processes resulting from this extend to the periosteum, and necrosis finally supervenes. The obstruction to the canal may be either in its continuity or at its mouth, in the latter case

caused by thickening of the soft tissues surrounding it or deformity of the adjacent bony parts.

The SYMPTOMS of sinus disease are often obscure, and DIAGNOSIS difficult. When *pain* is present, it may be of two kinds: the first is deep-seated, dull, and throbbing, and located in the neighborhood of the affected sinus. In addition to this, neuralgic pains of the most intense character may appear, sometimes distinctly radiating from the affected centre and sometimes difficult to trace. In the more chronic cases pain may be more or less wanting. External swelling over the frontal and maxillary sinuses may be present in extreme cases. The location of the pus exuded into the nasal cavity, although apt to be misleading, is sometimes a guide as to its source, that issuing from the ethmoidal cells or the maxillary sinus pouring downward from beneath the middle or the anterior border, respectively, of the middle turbinated body. By the method of transillumination pus may be demonstrated in unilateral disease of the maxillary and frontal sinuses, although this test is not always to be relied upon.

The principles of the TREATMENT of these diseases may be summed up under three heads—namely, free drainage, systematic cleansing of the cavities, and removal from them of diseased tissues and bone. The special application of these principles to the different sinuses requires separate consideration.

In general, however, it may be said that in case of acute inflammation occurring in any sinus active measures should be taken to subdue it, both by general measures and by such local means as shall subdue the swelling and congestion in and around the sinus-canal. Dilatation of the parts by sprays of cocaine, followed by the use of cleansing sprays, the use of steaming inhalations, and, finally, the absolute avoidance of all irritating applications, will often greatly hasten recovery. Cure may sometimes be effected in the less severe chronic conditions by removal from the points of exit of the sinus-canals of any hypertrophic tissue, polypoid growth, or other obstructive condition which may interfere with the drainage of the part. In cases not amenable to the above treatment more severe surgical measures involving forcible entrance into the sinus may be required.

The *interior of the frontal sinus may be approached* from one of three points—namely, through its *floor* from just *above the inner canthus* of the eye; from *in front*, by an incision parallel with the upper margin of the eyebrow; and from *in front*, by a vertical incision a little to the median line. The bony wall of the sinus may be so thinned as to be penetrated with ease. Should this not be the case, entrance may be effected by the use of the chisel or trephine. If necessary the walls of the sinus are scraped and diseased tissue, polyps, and diseased bone removed. In all cases drainage should be established from the sinus through the natural canal into the nasal cavity. To secure this Mayo Collier carries a piece of soft rubber tubing from above through the canal and out of the nose. The diameter of the tube is sufficient to completely fill the calibre of the canal, and thus prevent its walls from becoming thickened. To irrigate the wound the tube is put upon the stretch: its diameter is thereby lessened, and the antiseptic fluid is injected from the wound above downward and into the nose. The rubber tube is retained for from six to ten days, when it is removed and the outer wound closed.

Others advise that the cavity be packed with antiseptic gauze and

allowed to heal from the bottom, the external wound meanwhile being kept open.

Several methods are employed for *treatment of suppurative disease of the maxillary sinus.* These are of two varieties—namely, by entrance to it from *within the nasal cavity,* and from *without.* Where the ostium maxillare is sufficiently large and accessible, a small tube may be passed through it, and the interior of the antrum thus irrigated. In case the above conditions are not present, an artificial opening can be made through the wall of the antrum at the level of the floor of the nose. Through this systematic irrigation can be maintained.

By far the most popular way, however, is to enter the sinus from without, either by withdrawing a tooth and breaking into the floor of the antrum perpendicularly through its socket, or by drilling an opening horizontally through the alveolar process in that part known as the canine fossa.

If necessitated by the severity of the condition, a considerable section of the outer wall of the antrum may be removed and its cavity thoroughly exposed. Various devices in the way of tubes of metal or rubber are used for the purpose of keeping the opening patent, and of thus permitting the treatment to be continued for an indefinite length of time. Of the various methods mentioned, entrance through the canine fossa is, on the whole, the best.

Where **suppurative disease of the ethmoid cells** is present obstructive thickenings must be removed, polyps destroyed, malpositions of the anterior end of the middle turbinated body relieved, or the walls of the cells entered. Preliminary to the latter operation, it may be necessary to expose the region by the actual removal of the anterior end of the middle turbinated body. This having been done by means of the Jarvis snare or a suitable cutting forceps, the anterior wall of the ethmoid cells is penetrated, and, if required, the bony septa which divide the various compartments are broken up sufficiently to allow of the free irrigation of the whole cavity.

Disease of the sphenoidal sinus, the most difficult of all to reach, has sometimes been relieved by puncture of the anterior wall of the sinus and subsequent irrigation.

The TREATMENT of chronic disease of the maxillary sinus is difficult, and often exceedingly tedious operations upon the other sinuses are too serious to be entrusted to any but the most skilful hands.

When it is remembered that the cavity of the sinus is separated from the orbit by an exceedingly thin plate of bone, and that its proximity to the brain is also intimate, it will be unnecessary to urge the importance of duly appreciating the serious character of such operations, the observance of due conservatism in resorting to them, and the employment of a high grade of skill in carrying them out. It is safe to say that in no part of the body is a thorough knowledge of the anatomy of the parts more urgently necessary.

Treatment of the case after the operation should consist in thorough and persistent cleansing of the parts until relief has been gained.

DEFORMITIES OF THE NOSE.

Congenital deviations from the normal condition of the nose are sometimes found, consisting in absence or reduplication of the whole

organ or of any of its constituent parts, in complete or partial closure of its canals, or in abnormalities of size and shape of certain of its parts. With the exception of the last-named conditions, which are common, these deformities are rare.

Of the acquired deformities of the nose, deviations of the nasal septum are so common as to be the rule. Practically, they are the most important abnormalities of the nose with which the surgeon has to deal.

Undoubtedly the most common CAUSE of septal deflection is traumatism. Some of the worst cases, however, occur in those who have been mouth-breathers from pharyngeal obstruction, and in whom the disuse of the nose on the one hand, and its altered nutrition on the other, have been active causative agents in the production of the trouble.

FRACTURE OF THE NASAL SEPTUM.

The nasal septum is composed of three separate parts—the cartilaginous portion, the perpendicular plate of the ethmoid, and the vomer. Any of these three parts may be fractured alone or any part of them may partake of the injury. Fracture of the septum, therefore, may be divided into three parts: first, that of the perpendicular plate of the ethmoid; second, fracture of the vomer; and third, that of the septal cartilage.

Fracture of the perpendicular plate is not uncommon, occurring with fracture of the bones proper, especially where the fracture is extensive or comminuted. It may also be isolated, and in that case is likely to be found near the union of the perpendicular plate with the vomer. *Fracture of the vomer* is rare, and not likely to be attended with displacement. It is therefore difficult to recognize. *Injuries to the septal cartilage* may be of the nature of dislocation or fracture. The first variety is commonly met with and often difficult to remedy. The deformity resulting from it is not confined to the interior of the nose, the tip of the organ being thrown to one side and much injury done to the facial line. The accident is common in children, and is liable to pass unrecognized on account of the swelling which conceals it.

Actual fracture of the cartilage is more likely to happen in adult life, the cartilage in some individuals showing an early tendency to calcification, which, although not developed to an extreme degree, may be sufficient to render it comparatively brittle. It is due, of course, to direct violence, and this is generally associated with injury to the parts of the septum posterior to it. It is sometimes easily recognized and sometimes not, owing to the fact that few septa are originally straight and by reason of the swelling which has taken place. Palpation, rhinoscopic examination—if possible, under cocaine—and the use of the nasal probe will generally give the necessary aid in recognizing injuries received within the nose.

The fact that there is no external deformity of the nose may not prove that extensive injury has not been suffered within. Generally, however, the nature of the injury may be inferred by some change in its external contour, especially with regard to the tip of the nose, which will suggest the real nature of the case.

The TREATMENT is a matter always requiring a considerable amount

of care, skill, and judgment. In all cases great advantage is gained from an examination of the nose before swelling has taken place.

Dislocation of the cartilage in children is, as a rule, impossible to remedy by any known efficient means. Complete luxation having once taken place, the base of the cartilage is so loosened that it is impossible to retain it in its normal position, and even when it is retained from the earliest period after the accident it generally happens that the displacement will recur in spite of treatment having been carried on for a long period of time. With older subjects the case is somewhat easier, and even in children where complete healing of the parts has taken place considerable may be done at a period subsequent to the accident by surgical means. For the relief of these deformities Asch has attained success by incising the cartilage in the lines necessary to relieve the deformity, fracturing it at the points necessary to overcome its resiliency, replacing it in the median line, and causing the patient to wear for a number of weeks a perforated tube of hard rubber made to fit the parts. This tube may be manipulated by the patient after a little instruction, and its presence need not be irritating. This operation may be used with advantage in cases of deflection extending beyond the cartilage.

Operations upon the nasal septum are commonly called for and extensively practised. They may be divided in general into two classes :

1. Those for the removal of projections in cases where the normal thickness of the septum has been increased ;

2. The straightening of deflected septa whose transverse diameter has not been materially altered.

These two varieties of deformity may require widely different treatment. Projections from the nasal septum may be removed by the use of caustics, the cautery, or electrolysis. They may require the use of some cutting instrument, such as the saw, the knife, the chisel, or the forceps. The use of caustics is mainly applicable to hypertrophy of the soft tissues of the septum, and particularly those which occur on the anterior and inferior part. The galvanic cautery is of somewhat more extensive application on account of its greater destructive power. It may be used for the destruction of cartilage and even for bone. Electrolysis has been used with some success for the removal of small anterior projections of soft tissue.

For cartilaginous and osseous spurs other means will generally be required, although the electro-cautery is sometimes useful in these. Removal of these is best accomplished by some cutting instrument, the most popular of which is the simple nasal saw. The latter should be specially constructed for the purpose and of the best workmanship. The electric trephine, merely a variety of the saw, is often a valuable substitute for the latter. Variously constructed knives, scissors, and gouges are used either to separate the ridge or to reduce remaining projections after the use of other instruments.

The removal of septal spurs may be accomplished either with local or general anæsthesia. Where the operation promises to be severe the latter may be required. In nearly all cases cocaine will suffice. In operating strict aseptic precautions should be attempted, notwithstanding the evident difficulty of actually securing them in the nasal passages. The patient should be seated and his head firmly supported. The nasal cavity, having been cleansed and anæsthetized, should be carefully inspected, and the exact nature, extent, and direction of the proposed incision determined upon. In using the saw it is generally more convenient to cut from below upward. Everything being ready, the saw should be introduced, the line of direction carefully noted, and as little time as possible consumed in cutting through the fragment, the operation being guided by means of anterior rhinoscopy,

and every precaution taken to avoid injuring the neighboring parts. The distal end of the saw should always be probe-pointed, to avoid unnecessary injury to the membrane of the posterior part of the septum and of the wall of the pharynx, which latter, however, the saw should not be allowed to touch. The bony structures having been separated, the detached fragment should be finally separated by a smooth incision through the remaining mucous membrane, made either with the knife or scissors. In using the trephine the instrument is attached to an electric motor, and is applied by the aid of rhinoscopy to the anterior end of the projection. Revolving rapidly, it is caused to cut its way through the long diameter of the ridge.

Where the base of the spur is narrow, its removal may be accomplished with one introduction of the trephine. If it is somewhat broad, several such attempts may be required. In cases of unusual difficulty, and where the thickness of the septum will permit, a large core may be pierced through the longitudinal centre of the projection and its final removal accomplished with the nasal saw. Irregularities remaining after the use of the trephine should be removed with the aid of some suitable instrument.

Bleeding after operation is not usually severe, and in any case may be stopped by tamponing the nose with a narrow continuous strip of antiseptic gauze. The use of the tampon is often unnecessary, although, as a rule, air should be excluded from the nostril.

The shock of these operations is often severe. The patient should be warned of this, and should be treated with the same consideration, as to rest and general attention, as would apply to any other surgical condition, even slight operations upon the septum being sometimes followed by considerable general disturbance.

CHAPTER V.

SURGICAL DISEASES AND INJURIES OF THE FACE.

By Edmond Souchon, M. D.

Congenital Malformations.

Absence of face is called *aprosopia ;* more or less marked imperfections of the face are called *atelo-prosopia. Congenital branchial fistulæ* have been observed on the face on the line extending from the auditory meatus to the labial commissure, and also in the groove between the nose and cheek. *Congenital atrophy of the face* may affect the whole face or one side only. In *unilateral* atrophy the skin is shrunken, yellowish, hardened. In *sclerema neonatorum* the skin is waxy, hard, tense, cold ; the body lies motionless as if the face and limbs were fixed in death ; the child cannot open its mouth to suck ; the disease occasionally appears a few days after birth. *Albinism* is congenital absence of pigment in the skin, hair, and eyes.

Congenital hypertrophy of the face may include the whole face or only one side. Double face has been observed on a living subject. *Œdema neonatorum* is very rare in the face ; it begins in the lower limbs and ascends. *Ichthyosis* is, as a rule, congenital, although the disease is seldom noticed until some little time after birth ; it very rarely attacks the face. *Xeroderma* is the commonest form of ichthyosis, and is often nothing more than a dry, scaly condition of the skin. The *congenital " scrofulous " face* presents three types.

In the *sanguine type* the face is oval ; the skin is thin, transparent, the veins often showing through ; the complexion oftener dark than fair ; the expression is bright, sharp, and animated ; the eyes are bright, and often dark ; the eyelashes long, silky ; the nose sharp and long, the alæ contracted ; the lips are thin, the teeth are white and often brittle ; the lower jaw is small and angular ; the hair fine and silky, often dark, not over-abundant. In the *phlegmatic* or *melancholic type* the face is round and plump ; the skin is thick, pasty, muddy ; the complexion is usually fair ; the expression is more or less dull, heavy, apathetic ; the eyes are large and full, usually pale ; the nose is large, the alæ thick ; the nostrils open and dilated ; the lips are thick, especially the upper ; the teeth soon decay ; the lower jaw is large and broad ; the hair generally thick and coarse. In the type called *pretty struma* the coarseness of the features is toned down ; the lips are plump, but not tumid ; the face, like the body, is plump, but not flabby (Southam). Proper and long-continued specific treatment may improve these conditions.

Congenital syphilitic hypertrophy of the face in children or in young adults, presenting evidence of congenital syphilis, is characterized by prominence of the frontal eminences, imperfect development and depression of the bridge of the nose, opacity of the cornea, pits and scars on the face and forehead, cicatrices and fissures of the cheeks and at the

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angles of the mouth, malformations of the permanent teeth, especially of the central incisors of the upper jaw (Southam). Long-continued proper specific treatment will improve such appearance.

Birth-marks or *port-wine stains* are more frequent on the face than anywhere else; they may be very small or very large; they may be level with the skin or they may be raised. They should be treated as they are in other parts—with more care, if possible, on account of the cicatricial marks.

Congenital deviations of the face, or asymmetries, in which the face is thrown to one side, have been observed to a lesser or greater degree.

Acquired or Post-natal Malformations of the Face.—*Atrophy of the hair* comprises *alopecia*, which is loss of hair in circumscribed, well-defined areas, with a smooth and shining skin. *Pigment-atrophy* is called *leucoderma* or *vitiligo;* it presents patches of blanched skin, and is a loss of pigment in small or large areas. Although the neck is the most common situation for it, the face may also be affected. *Canities* is the loss of pigment of the hair-shaft. *Anidrosis* is absence of perspiration, or dry-face. *Atrophy of the cuticle* is usually a senile atrophy. *Atrophy of the whole face* or of a *side* or of a part of it has been observed after losses of tissue.

Facial trophoneurosis, or reflex or paralytic atrophy, is the name given by Shott and Romberg to a special atrophy affecting by preference the face, where it always remains unilateral : it is due to a lesion of nutrition allied to a functional disturbance of the nervous system. The cause is unknown : it is not a sclerosis, but an absorption of all the tissues, especially of the connective. *Hypertrichiosis* or *hirsuties* is excessive or abnormal growth of hair, very objectionable in women especially. *Trichorrhexis nodosa* is a nodular condition of the hair. *Tinea nodosa* is a nodular concretion consisting of fungus spores : it weakens the hair, which splits and breaks; it sometimes affects the hair of the whiskers, beard, or moustache. *Pigment hypertrophy* is called *lentigo, ephilids,* or *freckles* when it assumes the shape of a localized deposit of pigment : it is most commonly situated on the face, especially about the nose and cheeks; in the pregnant female it is called *chloasma uterinum.* It is the ordinary *chloasma* or *liver-spots* when presenting a circumscribed deposit of pigment, which grows more and more diffuse so as to cover large areas. *Telangeiectasis* is a condition in which the capillaries are considerably dilated over a larger or smaller area of the skin : it occurs on the face and neck especially, particularly in elderly people, in the form of small spots constituted by small tufts of dilated capillaries; the disease resembles the slighter form of vascular nævus. *Tinea versicolor* is caused by a special fungus : it presents roundish, slightly raised, scaly patches, with well-defined borders, a peculiar brownish discoloration; it is very rare on the face. A *nævus pigmentosus* or *mole* is a simple deposit of pigment with or without raising of the corresponding part of the skin. The *bronze face of Addison's disease,* dermato-molasma, is a discoloration due to a peculiar condition of the suprarenal capsules. *Xeroderma pigmentosum,* or *Kaposi's disease,* is a very rare affection : the initial lesions are small pigmentary spots appearing chiefly on the face, neck, and arms; they form numerous tumors which run a rapid course and end in death. *Pityriasis* is characterized by a brawny desquamation : it usually occupies the hairy parts; it is much more rare on the face than on the scalp. Pityriasis rubra pilaris presents at the orifice of the hair-follicles characteristic papules; on the face the lesions are often of a seborrhœic type, a red base being covered with adherent crusts. *Ichthyosis* is rare on the face. A scaly-face skin is often met with in old people. *Psoriasis* consists of flat, dry patches of variable size covered with white, silver-gray, or asbestos-like scabs : it rarely affects the face, except in young subjects and in inveterate cases. *Hyperidrosis* is excessive sweating : it is sometimes limited to the course of the fifth nerve. *Seborrhœa* is an excessive secretion of sebaceous matter. *Seborrhœa oleosa* is an excess of oil-like secretion. *Seborrhœa sicca* is excessive secretion of sebaceous matter with excessive proliferation of unaltered epithelial cells. Seborrhœa in both forms is more common on the scalp, but the eyebrows, moustache, and beard are sometimes the seat

of dry seborrhœa. On the face the oily form is more frequent, affecting especially the middle third of the face, usually the alæ of the nose and naso-labial groove; also the corners of the mouth and the ears. Seborrhœa most invariably begins on the scalp; then it spreads on the face to the eyelashes. *Dermatolysis* is the hypertrophy of the integuments and subcutaneous tissues, which are all loose, pliable, feeling like fatty tissue: it is an exaggerated form of molluscum fibrosum, marked by large flaps or folds of hypertrophied skin; their commonest site is about the neck, face, buttocks, and chest; the flaps are often deeply pigmented, thickened, indurated, and warty; hypertrophy of the bones and other subjacent tissues may also be present. *Rhinoscleroma* is peculiar to the nostrils and to the skin around them: it begins by nodules in the cutis, which coalesce to form a hard growth with a smooth glistening surface, which spreads inward from the lip and downward to the pharynx from the posterior nares; it is a rare affection. *Scleroderma* is a diffused thickening and hardening of the skin; the skin is rigid, tense, hard like that of a frozen corpse, but without the coldness; the features are drawn and the face becomes fixed into an expressionless mask. In atrophic scleroderma the skin shrinks and becomes waxy-white in color; the face and upper limbs are the only parts attacked. *Leucoderma* is a similar condition, but without hardening of the integuments. *Morphœa* is a circumscribed scleroderma, lardaceous in appearance, mottled, with pink areoles; the lesions vary in size from half an inch to the palm of the hand; the patches on the face sometimes follow the course of the fifth pair. Morphœa is also called *Addison's keloid*. The face is a favorite site for it; it presents well-defined waxy patches of a pale pink and yellow color; it is due to some vasomotor disturbances. *White keloid* is a kind of scleroderma, not true keloid. The *keloid of Adibert* is a different disease, which develops spontaneously on cicatrices, especially on burns. *Scars* on the face grow with the body in the course of time. *Neurotic* or *neuralgic hypertrophy* is due to persistent neuralgia, usually affecting one side of the face only: all the tissues, even the bones, participate in it. *Acute circumscribed œdema* arises suddenly and subsides rapidly, only to develop in another part: its favorite seat is the face and the genitals. *Frog-face* is due to intranasal tumors, which, growing toward the face, raise and spread the nose and the surrounding structures. *Elephantiasis* presents the characteristic "leonine face:" it is the tubercular and mixed varieties which have a predilection for the face, nose, lips, cheeks, eyelids, chin, ears. The affected skin, especially in the nodular stage, is often the seat of seborrhœa; this gives the nodules, particularly on the face, a characteristic burnished appearance. The hair in the affected areas fall out. In the vast majority of cases of nodular leprosy the ends of the ears are the first parts affected. *Elephantiasis Arabum* is a chronic hypertrophy of the skin and subcutaneous tissues: it affects the face rarely. In the infiltrated form the face is affected after the limbs. *Acromegaly* affects also the face, including the soft and the bony structures.

Myxœdema is a hard swelling of the face and neck and of the extremities: it is also called cachexia strumipriva, cretinoid condition, thyreopexa. It is a rare disease. Myxœdema and cretinism are totally different diseases. It is due to some destructive changes, such as fibroid degeneration, interstitial hyperplasia of the connective tissue, syphilis, atrophy of the glands; to the removal of the whole of the thyroid; in some operated cases it is due to the atrophy of that portion of the body which had been left on purpose. The anatomo-pathological lesions are hyperplasia of the connective tissue of the face and neck and extremities; the connective tissue is increased in quantity and density; there is excess of mucin in the skin and in the blood; hæmoglobin is diminished; the red blood-corpuscles and the fibrin vary. The power of the red blood-corpuscles to take up oxygen may or may not be deficient. The anæmia of myxœdema is said to be due to the suppression of the hæmopoietic functions, to alteration of the regulation of the cerebral circulation, to the loss of function of the thyroid, which is an organ of depuration and elimination.

The SYMPTOMS are—the skin of the face, neck, and later of the extremities, is swollen in a characteristic manner; the speech, the motions, the intellect, all the mental and bodily functions, decline; in young subjects mental development is arrested. Its COURSE is slow; it is always progressive, without any halt or improvement. Its DURATION extends usually over a year. Its TERMINATION is death.

The preventive TREATMENT consists in leaving a piece of the thyroid body in

all cases of total extirpation of the organ. The curative treatment consists in giving thyroid extract by mouth, by hypodermic injection, or by grafting a piece of the thyroid body of an animal into some part of the patient's body.

Acquired Deviations of the Face.—Mutilations are on record in which one side of the face is natural, and the other drawn so as to present the expression of perpetual laughter, as depicted in Hugo's "*L'Homme qui Rit.*"

Injuries of the face would be still more frequent than they are, on account of its exposed position, but for the small size, excessive mobility of the head, and the protection afforded by the arm and forearm instinctively brought up quickly in front of the face.

Burns are usually deeper than they seem at first: they are often followed, in the mildest forms, by at least coarseness of features, ugly cicatrices, and deviations, whose result is dribbling of the saliva: the cicatrices sometimes interfere with the movements of the lower jaw. It is important to prevent the patient from scratching himself during sleep or delirium, so as to prevent a frequent and potent cause of increasing the deformities. Burns by acids, striking the face accidentally or by a criminal hand, are the most frequent of the kind; in criminal cases it is the face that is specially aimed at; on account of the disfigurements that follow and of the loss of the sight these burns are of the gravest character. No special treatment is here required except greater diligence.

Freezing or *frost-bite* is common about the face on account of its exposed position. Reaction should be brought about very slowly, so as to limit the damage and leave as little cicatrix as possible. When blebs form, it is of bad omen. There often remains after recovery a purple color, for which subcutaneous injections of ergotin have been recommended.

Contusions are often followed by great swelling and discoloration, especially about the eyelids (black-eye): they are specially frequent in children, who have so many falls; they affect especially the prominent parts. When the injury is located over a bone, there is formation of a hæmatoma; when in soft regions, the blood becomes infiltrated.

Contused and lacerated wounds often present a lesion of the deep much greater than of the superficial parts, as it is the underlying bone that has done the cutting.

Contused wounds produced from without are the most frequent; sometimes they are very extensive, such as a result of the kick of a horse, terrific falls, etc., and large portions of the facial mask are torn away and hang down. Deep sutures can be placed to advantage to support and approximate the parts.

Punctured wounds, when deep, are apt to be followed by subcutaneous hemorrhage: they may penetrate one of the cavities, where the weapon may be broken, as in the maxillary sinus, orbit, cranium.

Incised wounds usually gape much: very often fatty lobules protrude between the edges of the wound. Sabre wounds sometimes carry away the whole of projecting parts; they bleed freely. Great care should be taken to approximate the edges properly, so as to avoid unsightly cicatrices: fine needles should be used, also fine silk; plaster strips or collodion should be placed over them. These wounds unite generally

by first intention, because the skin, subcutaneous tissue, and muscles form but a single matted layer or structure.

Gunpowder stains should be removed at once and thoroughly : if they are allowed to remain, they will remain for life. If necessary, cocaine or an anæsthetic must be used ; the parts should be first scrubbed with a hard nail-brush ; then all the grains of powder must be picked out, one by one, employing a cataract needle ; a 1 per cent. solution of mercuric chloride will facilitate the removal of the grains of powder.

Gunshot wounds of the soft parts of the face alone are very rare. There exists a case on record of perforation of both cheeks by a bullet without injury to the bones or teeth in an officer who was wounded when uttering an enthusiastic hurrah. Gunshot wounds from a distance are the rule in war, and may be terrific : in one case the whole face was destroyed except the eyes, and the patient survived, feeding through a tube which he introduced in the œsophagus. Gunshot wounds at close range are most commonly due to suicidal efforts. Such wounds may be complicated by the lodgement of a ball or other foreign body in any one of the cavities of the face ; by the lesion of some organ or nerve of special sense ; by fracture of the base of the skull ; by injury to salivary glands, teeth, lachrymal glands. Besides, the softness of the bones allows the missiles to penetrate deeply and the tissues to contract over them ; hence arises great difficulty in removing them.

Arrow wounds produce great bleeding ; all the above remarks concerning gunshot wounds are applicable to them.

The *immediate complications* of the wounds of the face are *emphysema*, due to fracture of nasal fossæ or maxillary sinuses; wounds of *Stenson's duct ;* cerebral contusion : this is not very frequent nor severe ; it is, on the contrary, remarkable how few cerebral symptoms develop after violent injuries of the face; this is due to the fact that the bones are soft and yield readily. Wounds of the deep arteries give rise to hemorrhage through the mouth, without our being able to ascertain positively whence the blood comes. The *secondary complications* are *œdema* of tongue and pharynx, interfering with deglutition, cephalic tetanus, persistent neuralgias, cramps, and contractures.

Secondary hemorrhages are frequent in lacerated and gunshot wounds of the face ; they usually take place between the fifth and the twenty-fifth day : it is the small deep vessels that are the troublesome factors. No styptics should be used, especially here : it is preferable to use methodical plugging with long narrow strips that are well packed in small segments in all the nooks and corners with as hard a compression bandage as the patient can stand. The bleeding arteries should be ligated *in situ* if possible, but this is very difficult, and often unsatisfactory on account of the inflamed and sloughing condition of the tissues. By applying a provisional loop ligature around the common carotid the hemorrhage may be controlled until a thorough search and a satisfactory ligature of the bleeding points be accomplished *in situ*, when the provisional ligature is removed. In such cases the common carotid should be exposed close to its bifurcation, so that if the above procedure should fail, the external carotid is within easy reach. It might be well borne in mind that it is the external carotid that must then be ligated, not the common carotid, on account of possible cerebral complications. In extensive or general bleeding it may be necessary to ligate both external carotids : in such an emergency the ligations should be applied above the origin of the linguals.

The SEQUELS of injuries of the face are reflex contractions of the muscle of the face from a wound of the face or scalp, constrictions of the jaws, ectropion of the lids or lips, atresia of the mouth. These injuries are sometimes followed by *amaurosis*, especially if they occur near the orbit or the malar bone ; the lesion is often a dislocation of the lens or a detachment of the retina ; sometimes there is no detectable lesion.

Mortality of injuries of the face is comparatively low, because the vessels and the bones are small, the bones are thin, the parts naturally drain well through the nose and mouth, and the vascularity and the nutritive powers are here at their best. During the War of Secession 90 per cent. recovered, some with horrible mutilations.

Fractures of the nose are treated elsewhere. (*Vide* Vol. I.)

Poisoned wounds, stings of insects, of spiders, etc. are common, because of the exposed condition of the face; the swelling spreads rapidly and is particularly disfiguring. In cases of bites of horses or of dogs there is a flap corresponding to the upper jaw of the animal and one of the lower jaw. *Bites of rabid animals* are much more rapidly followed by hydrophobia, because the distance to the brain is so much shorter than when the hand or any other part is the site of the injury; also because, the teeth penetrating at once into the tissues without passing through any clothing, the inoculation is more thorough and more virulent. All poisoned wounds of the face should be treated as in other regions.

Neuroses of the Face.—*Anæsthesia* of the skin of the face is usually due to the paralysis of the trifacial; it is a symptom of a lesion of the nerve-centres. *Double paralysis* of the face is called diplegia. *Facial paralysis,* or Bell's palsy, is usually caused by brain lesions, but may be due to the effects of cold on the nerve, of blows, of wounds or operations injuring the nerve in some point of its course or at its point of emergence; diseases of the temporal bones (fractures or caries), or otorrhœa. Its peculiar symptoms are inability to close the eye, prolapse of the cheek, eversion of the lower lip, the deviation of the face toward the sound side. When the patient laughs, the expression of the whole face is most peculiar and characteristic. The TREATMENT varies with the cause. *Facial hyperæsthesia* comprises dermatalgia, or painful skin, or pruritus or itching, especially of the skin of the beard or of the nares; it is rather rare. *Facial neuralgia* is called *tic douloureux* when the pain is accompanied by contraction of the muscles; its special cause here is often a carious tooth, although the tooth itself may be painless; the other causes are painful cicatrices, foreign bodies, callus including a nerve, tumors, inflammations, diseases of the petrous bone or intracranial tumors. Its special TREATMENT in obstinate cases is the stretching or the section of the nerves at their points of emergence (neurotomy and neurectomy) or the removal of the Gasserian ganglion. *Facial spasm,* or *convulsive tic* without pain, is a clonic spasm causing contortions of the side of the face: it ceases during sleep. Cephalic hydrophobic tetanus may result from a bite of a non-rabid animal; it affects the course of a cranial nerve; the facial nerve is paralyzed on the side of the wound. The SYMPTOMS are those of hydrophobia; the face is congested and haggard.

Chromidrosis and *purpura* are mentioned here for want of a better place. Chromidrosis is a colored secretion of the sweat and sebaceous fluids, usually blue in color, or red, yellow, green, or violet: it is usually symmetrical; its favorite site is the eyelids, next the cheeks, the forehead, the sides of the nose, sometimes the whole face and the body. Purpura is the extravasation of blood in the cutis; it is rare in the face compared with the other parts of the body; it is there most commonly situated in the eyelids. The TREATMENT must be general and directed to the blood.

Furuncles or *boils* most frequently affect the face and neck. *Car-*

buncles of the face are comparatively rare and nearly always fatal. These lesions are particularly grave about the face, because of the septic absorption by the facial vein and its direct conveyance to the sinuses of the brain. Carbuncles should be freely incised or curetted at the very outset. *Erysipelas* is common : it is usually due to some lesion in the interior cavities, buccal, nasal, pharyngeal, Eustachian tube or external auditory canal ; it emerges from the tip of the nose or from the lachrymal points or from the external auditory canal. When it first travels through the Eustachian tube and the middle ear it is preceded for two or three days by most agonizing pains : it is more serious here than anywhere else, because of the propagation to the brain and membranes. It seldom stops until it has gone over the whole face and head, seldom extending beyond the neck to the trunk : it usually leaves the features coarser than before its advent. Of course the interior cause must receive proper attention during the attack, and also afterward in order to prevent a return : it requires here no particular treatment. Erysipelas of the face is sometimes complicated with pericarditis, myocarditis, and oftener with endocarditis (Gubler).

Malignant pustule is also comparatively frequent, for the reason of easy access to the face: it is more fatal here because the radical means of treatment are not so easily applied as on the hands ; also because of the close proximity of the brain and its sinuses. *Glanders* shows externally first by an inflamed and ulcerated condition of the nostrils and upper lip. *Cellulitis* is rare, because of the adhesion of the skin to the muscles and of these to the bones. Congestions of the face do not spread easily for the same reasons. But septic inflammations are often followed by much swelling, œdema, and hardness. They should be treated as in other regions. *Cellulitis and abscesses* of face are usually due to diseased teeth or to osteoperiostitis of the jaws. Abscesses are also comparatively rare : most frequently they originate from the root of a decayed tooth. Abscesses of the face should be incised with the greatest care, bearing in mind the direction of the folds or wrinkles of the vessels, the nerves, Stenson's duct,—all this on account of the scar that may follow ; for these reasons it is often best when circumstances permit to let them open for themselves, when the scar is reduced to a small round white spot less noticeable than a cut. *Phlebitis of the facial vein* is rarely primary : it usually follows other inflammations of the face, especially furuncles and carbuncles, and particularly those of the upper lip. It is characterized by rapid swelling, with œdema, intense pain, sensation of strangulation ; the face is earthy pale, the course of the veins marked by blue lines.

Gangrene of the Face.—*Gangrene of the face* is rarely primary : it is usually due to injuries, to carbuncles, to malignant pustules. *Cancrum oris*, or *noma*, is peculiar to the cheeks. Great care is necessary to limit the following deformity as much as possible. *Raynaud's disease* is symmetrical gangrene of the extremities, including in this term the tip of the nose and the ears : the order of frequency is the fingers, toes, heels, nose, ears.

Ulcers of the face may be due to many causes. *Tubercular* ulcers are the most frequent outside of syphilis ; they are called lupus, and the face is their favorite site. Lupus erythematosus is not tubercular.

Lupus non-exedens is characterized by an eruption of pale or reddish tubercles which ulcerate, become covered with white scales and scabs, which on coming away leave behind a smooth white depressed cicatrix. Lupus exedens destroys by ulceration ; lupus non-exedens destroys by atrophy.

The favorite site of lupus is the face. *Lupus vulgaris,* or *malignant herpes,* is also a form of tubercle of the skin due to the bacillus : it appears as small tumors on the skin, especially on the forehead, cheeks, and nose ; the lesions are grouped tubercles of apple-jelly color and consistency, smooth, tending to ulceration. It is more grave ; it resembles epithelioma, but is less painful ; the edges are not as hard and elevated ; the favorite site of lupus is the face, especially the nose and the neighboring part of the cheeks. *Nodular lupus* presents more or less localized nodules, tubercles, and nests, reddish or yellowish pink ; often quasi-gelatinous ; it usually attacks the cheeks near the junction of the alæ and the upper lip. *Diffused lupus* is superficial, less inclined to form nodules and nests : affects the cheeks and nose most frequently. *Lupus seborrhœicus* (Volkmann) presents irregular nodular patches on the cheeks and nose, covered with dirty-looking skin, crusts fatty to the touch : after partially scraping off the scab the underlying skin appears red, sore, as if studded with fine warts ; but when examined with a lens are seen a number of fine holes, which are the enlarged openings of the sebaceous ducts : each single fatty crust has a fine prolongation of the latter, which becomes detached from each opening.

Ulcers of the face which resist ordinary treatment should be cocainized and curetted ; if necessary they should be extirpated like cancers.

The *Biskra button* or *Aleppo boil* is a tropical disease beginning by a boil which leaves a foul ulcer : it is due to a micro-organism. Syphilitic ulcers are common in all their forms and varieties—papular, tubercular, rupial, etc. General specific TREATMENT is indispensable.

Indurated chancres may occupy any part, but they are more rare than around the mouth ; they are sometimes two or three in number ; they are usually accompanied by a hard and purple œdema, with greater nodular engorgement than in other situations. *Chancroids* or *soft chancres* of the face have been observed, but are very rare. Tertiary syphilitic ulcers are tuberculo-ulcers and resemble lupus : they often present here a rapid evolution, and are rebellious to specific treatment, destroying soft parts and bones alike, followed by destruction of nose, and cicatrices, causing atresia and ectropion of the natural orifices.

Yaws, or *frambœsia,* presents reddish papules, tubercles, or tumors studded with yellow points, which ulcerate : it is a very rare disease. It may appear first on the lip ; sometimes the papules are arranged in rings, especially round the eye, nose, mouth, and the genitals. Tertiary ulcers of yaws are also common about the lips.

Cancerous ulcers are limited usually to the skin ; however, cancers on the deeper tissues, and especially the bones, finally ulcerate. Cancers commencing on the skin are the squamous epithelioma and the rodent ulcer. *Rodent ulcer* is a form of epithelioma : it is remarkable that almost every case of rodent ulcer has its seat within an area bounded by a line drawn from the uppermost point of the pinna to the root of the nose, and another drawn from the lobule of the ear to the columella of the nose. It exceptionally occurs on the hands. It must be thoroughly curetted or destroyed by pastes or extirpated. (*Vide* Vol. I. p. 429, Figs. 177, 178.)

Epithelioma is the most common of all cancerous affections of the face, which is a favorite site for it. It is important to remember its forms and varieties—superficial or flat epithelioma, presenting scales or a grouping of papules or an inflamed sebaceous outlet ; the indurated or circumscribed ; the papillary ; the infiltrated or diffused, which resembles the condition of chronic inflammation : sometimes it begins by separate spots which coalesce ; there is no elevation of the diseased

parts. Epithelioma of the face when small should be curetted or attacked with pastes, but when of size or deep, extirpation is the best remedy : early interference is most desirable to avoid large scars.

In operating, grafting and plastic operations must be resorted to to reduce the cicatrices and deformities to a minimum. The lymphatic nodes receiving the lymphatics from the infected parts should be removed if in the least indurated : because of the neglect of this it is common for the disease to show on the parotid region or the submaxillary, requiring there much more dangerous and extensive operations for the eradication of the disease.

Fistulæ of the Face.—Fistulæ of the face are not very common : they may be congenital—*e. g.* of branchial origin ; they may be lachrymal or salivary, or due to an incised cyst which does not heal, to a carious tooth, or to a diseased bone. One of their peculiarities is the scar that follows their healing, and which most commonly tells of a disease of the bone.

Scrofuloderma of the Face.—Scrofuloderma is the general name for all diseases of the skin of a strumous or scrofulous nature. We must bear in mind that scrofula is a particular constitutional state in which bacilli, especially tubercle bacilli, readily flourish, but not tubercles alone ; the lesions in scrofulous subjects are apt to take on a character of chronic inflammation of a peculiar type, in which a tendency to suppuration and formation of unhealthy sores is the most marked feature.

Lichen scrofuloderma is a papular eruption, the elements of which are not larger than a pin's head, are flattened, and are very slightly resistant; it is very rare on the face. Erythema induratum scrofulosum is formed of chronic inflammatory, deep-seated nodules; it is rare on the face.

Strumous dermic gummata, or scrofulo-tuberculosis or attenuated tuberculosis, are characterized by a tendency toward caseation and the formation of a cold abscess. Strumous ulcers are due to the extension of the inflammatory process from caseating lymphatic nodes to the skin covering them, or to the formation of a nodule or circumscribed induration under the skin, or to extensions from bone which is the seat of tubercular osteomyelitis : they are common on the face and on the hands.

Tuberculoderma of the Face.—Tubercular ulcers, due to primary tuberculosis of the skin, are ulcers with infiltrated, ragged, and undermined edges, and a slightly indurated floor covered with yellowish tubercles moistened with a thin and scanty secretion : they may occur on the face, on the head, and elsewhere. They are sometimes due to breaking down of small tubercular nodes preceding or following pulmonary or intestinal tuberculosis. They are generally situated at the junction of the skin and mucous membrane, about the corners of the mouth and margin of the nares, especially in cases of lung disease.

The TREATMENT of these diseases has already been described.

Syphiloderma of the Face.—Syphiloderma includes all the diseases of the skin of syphilitic origin. Primary sores or chancres have already been mentioned above : they may occur on the lips, cheeks, tongue, from smoking infected pipes, from using infected glasses, forks, spoons ; from kissing ; from dentists' instruments ; from unnatural practices. Of the secondary manifestations the eruptions affect usually the face last : they may be papular, tubercular with or without ulceration ; rupia or alopecia of beard, eyebrows, eyelashes. Small papules may form a kind of circlet on the brow round the margin of the hair

(corona veneris). The more common position of tertiary syphilitic lesions is the forehead and the margin of the scalp. In congenital syphilis the face sometimes presents a senile aspect. Tertiary ulcers have already been mentioned above.

The TREATMENT must be practically general and specific.

Actinomycosis of the face has been observed under the form of tubercles, hard, movable, indolent, soon forming abscesses, and then ulcers : it is distinguished from all other similar lesions by the special parasite.

Tumors of the Face.—Some tumors of the face originate from the spheno-maxillary fossa and become superficial on the cheek.

Of the *gaseous tumors* we will mention here *emphysema* of the face, due to fractures and dislocation of the nasal, lachrymal, and superior maxillary bones or to rupture of the nasal mucous membrane, with penetration of air into the tissues ; it calls for prompt reposition of the bones and pressure to prevent the spreading of the disease to the neck and larynx.

To the *fluid tumors* (blood, serum, pus) the following points of peculiar interest apply : *Liquid hæmatomata* should not be punctured nor incised, but should be aspirated in time if they resist compression. *Aneurisms* of the face are rare : they are usually traumatic. A lymphatic nodule raised by the facial artery may be mistaken for an aneurism. *Ectasis of the facial vein* has been observed once near the commissure. *Angeioma* or *erectile tumor* or *nævus* of all kinds from the birth-mark to the venous and arterial, from the small or limited to the broad and diffused, is rather common on the face. The same means should be employed here as elsewhere, bearing in mind the cicatrix and deformity that will follow. *Lymphangeioma circumscriptum cutis* is characterized by the formation of vesicles, forming patches of greater or lesser extent : they have been found on the face, limbs, neck, and shoulders. The essential features of the condition are overgrowth and dilatation of the lymphatic vessels ; they should be curetted or extirpated.

Lymphangeioma of the face is frequent : the face is its site of predilection. It is always congenital : it corresponds to what is called congenital hypertrophy, and may be limited to one region ; when incised the lymph runs out. *Macromelia* is congenital hypertrophy of the cheek. Cystic lymphangeioma resembles serous multilocular cysts of the neck : the cheek is raised by a tumor of variable size, almost round, limited or diffuse, lobulated, with ill-defined fluctuation ; it may extend under the zyomatic arch. Upon a superficial examination it resembles œdema, but by palpation isolated hard nodules are felt. *Cysts of the face* are serous and multilocular, branchial, sebaceous, sudoriparous, salivary. *Hydatid cysts* are very rare, but exist : they are not usually diagnosed unless punctured. Sometimes the puncture cures them : it is well, therefore, to wait before extirpating them.

Solid tumors, not elsewhere considered, present the following varieties :

Milium is a white and pearly mass of the size of a millet-seed, due to an accumulation of sebaceous matter in the duct of the gland, not in the gland itself. Milium is seen most frequently on the face, especially on the cheeks, eyelids, temple, and forehead. On the eyelids these swellings coalesce, forming flat masses which are sometimes so hard as to deserve the name of cutaneous calculi. A variety found on the face presents under the form of tiny disks with a minute, slightly depressed puncture in the centre, suggesting a fatty degeneration of the epithelium around a follicle. *Colloid milium*, or *colloid degeneration of the skin*, is rare : it presents small yellow, translucent, cyst-like formations containing a gelatinous substance. They affect chiefly the upper part of the face. *Comedones* are pimples with a black spot in the centre : when squeezed, sebaceous matter oozes out that resembles a black worm. They are most frequent on the face about the

nose, the cheeks, and the forehead. When very numerous they produce an appearance like grains of gunpowder imbedded in the skin; when squeezed out they look not unlike small maggots. A parasite, the dermodex or acarus folliculorum, is sometimes found in comedones. *Grouped comedones* have for a favorite situation the flush area of the face, and they form symmetrical groups of black points smaller than the ordinary comedones. *Xanthoma* is formed of plates or nodosities of a yellow or yellowish-white color imbedded in the corium: it presents the flat or planum and the nodular or tuberosum varieties. Xanthomata are most frequent on the face near the eyelids; they are symmetrical; they look like a circle of wash-leather set into the lids. *Xanthoma diabeticorum* differs from the above by presenting a raised red area around the yellow spots; it resembles acne; it seldom affects the face. *Nævus pilaris* is a hair-mole. *Acanthosis nigricans* is a peculiar pigmented condition of the skin with warty growths: in the few cases on record the pigmentation has occurred more or less suddenly. The face is first affected, then the neck, etc.

Molluscum sebaceum is a projecting tumor formed by a dilatation of the sebaceous gland, due to the accumulation of the secretion inside of it. *Molluscum contagiosum* is a small pedunculated or sessile growth, from the size of a pin's head to that of a pea, with an open orifice, giving exit to sebaceous matter upon squeezing it. It is due to the hypertrophy of the gland, not to retention of the secretion: it seldom attains a large size on the face. A variety is formed of small growths like tiny mother-of-pearl shirt-buttons, with a central depression and a hole leading to the tumor: at first they are sessile, but become pedunculated. They are most common on the face, the eyelids being a favorite situation. *Molluscum epitheliale* is a tumor-like hypertrophy of the epidermis, umbilicated, pearly-looking, sessile, varying in size from a pin's head to that of a split pea. The lesions are usually grouped and multiple; they are considered contagious; they affect especially the eyelids at the inner angles.

Callosities are rare. *Horny excrescences* have here a site of predilection. *Papillomata* or *warts* may be small or large: this affects their mode of treatment. They present the following varieties: the vulgar, plane, filiform, digital, acuminated, sessile, pediculated. *Flat warts* (verruca plana) in young persons are most common in the face, particularly the forehead. *Verruca seborrhœica*, or *seborrhœic wart*, consists in multiple patches of warty growths; the face is rarely attacked; it is most common in old people.

Hæmatomata containing clotted blood, usually following injuries and resisting compression and aspiration, should be incised with as small an opening as possible, on account of the cicatrix. They are most commonly seen on the face; the eyelids are their favorite situation. Hæmatomata formed of solidified fibrin, resulting from blows or cured aneurisms, are extremely rare.

Sebaceous cysts, or *steatomata*, are most commonly seen on the face near the scalp; usually their dissection here is more difficult than might be thought at first. *Dermoid cysts* may occur on the face occasionally; they are sometimes very numerous and resemble fibromata, but on cutting into them a sebaceous-looking material escapes. *Adenoma (sebaceous)* occurs chiefly on the face: it consists of small, firm, whitish or yellowish, solid tumors firmly imbedded in the skin at different depths or projecting from it. These are sometimes grouped about the end of the nose; they vary from the size of a pin's head to that of a pea; they are sometimes red, owing to the dilatation of the capillary veins on their surface; the lesions are usually symmetrical, and, though thickly crowded together, they do not run together to form patches. They present no opening: when pinched inspissated sebum can be squeezed out of them. They are usually congenital, though further crops of lesions appear after birth, especially at puberty; they undergo little change.

Telangeiectasis, acne rosacea, warts, nævi, keratosis pilaris, etc. often coexist with adenoma sebaceum; the patients are usually of a low grade of mental development.

Epithelioma adenoides cysticum is formed by small tumors which become shining and translucent, containing one or more minute white, brightly-refracting milium-like bodies: they are firm, but not hard, and can be felt imbedded in the skin. The most common sites are the space between the eyebrows, the root of the nose, the nostrils, the cheeks, the upper lip, and, to a less extent, the chin: they are so thickly clustered together as to form disfiguring lumpy patches; they may occur on other parts of the body.

Syphilitic gumma, and *diffused syphiloma* of the face exist and resemble leprosy; they usually follow syphilis of the lip. *Lipomata* are not often met with on the face: they are usually small and numerous, as in all situations where the bones are superficial; they are sometimes congenital. *Branchial fibro-chondromata*, also called auricular appendages, supernumerary auricles, congenital appendices of the face, are not very rare: they are congenital. Their surface is formed of skin: in the centre is often found a cartilaginous stem; they are most common in front of the tragus or on it, but they are also seen in all the regions of the branchial arches; also on the cheek on a line joining the external auditory canal to the labial commissure or below the line—in one case on the lower lip under the mucous membrane. They are excessively rare in the other regions of the face. They may be symmetrical; are about one-third of an inch long; are conical or club-shaped or pediculated; in the pre-auricular regions they are often multiple, and arranged in pairs along a vertical line, and may be symmetrical. After birth they seem to increase, and then they remain stationary; sometimes they are associated with branchial fistulæ. *Fibroma* of the skin, or *fibroma molluscum*, presents pear-shaped or roundish tumors covered by smooth skin, usually pediculated, but sometimes sessile: it is commonest on the face next to the trunk. Diffuse fibroma is a molluscum in which the tumors are large and attached by broad bases: they are usually multiple and overlap each other, forming folds of loose skin with dilated sebaceous follicles. Hard fibroma, or neuro-fibroma, is rare on the face, in size varying from a pin's head to large dimensions. Large hard fibroma is rare outside of the maxilla. *Keloid* is most common after burns. Addison's keloid is not a keloid proper, but a form of morphœa; the keloid of Adibert develops spontaneously on cicatrices, especially on burns. Do not extirpate a growing keloid. *Neuromata* are very rare. *Myxomata, myomata*, may all occur on the face, but very rarely. Myxœdema may be regarded as diffused myoma. *Osteomata* of the malar bone are occasionally met with. *Encephaloid* is rare on the face outside of the bones. *Sarcoma* of the skin, according to Baker, is the most frequent source of sarcoma, but Kaposi says that in the majority of cases the process in the skin is secondary to growths arising in the lymphatic nodes or the deeper structures. Sarcoma of the face is sometimes congenital. The melanotic form of cancer is relatively frequent on the face: it often follows ordinary angeioma or pigmentary nævi. Still, sarcoma of the face is rare outside of the bones.

Mycosis fungoides is a malignant neoplasm of the verrucose type: it is rare on the face. Kaposi's disease, or xeroderma pigmentosum, is extremely rare; it consists of numerous tumors which run a malignant course, and after extensive

destruction of the tissues cause death by exhaustion. The initial lesions are small pigmented spots which resemble freckles, that appear chiefly on the face, neck, and arms.

Operations of the Face as a Whole.

One of the points of importance about operations on the face is to endeavor to leave as little disfiguring scar as possible.

Operations on the Branches of the Fifth Pair in Cases of Inveterate Neuralgia.—*Neurotomy*, or section of the frontal nerves at the point of emergence at the supraorbital foramen, of the superior maxillary at the infraorbital foramen, and of the inferior dental at the mental foramen, affords only temporary relief. (*Vide* also p. 122.)

Neurectomy, or resection of a portion of these nerves as far as they can be traced in the canals and grooves that lodge them, gives more durable relief, but many cases recur. The inferior dental nerve is more thoroughly exposed by trephining through the outer table of the lower maxilla along the course of the inferior dental canal.

Resection of the branches from the *Gasserian ganglion*, or of the ganglion itself without the motor root, gives more permanent relief than any other course, but it is a very grave operation.

In *Rose's method* the ascending ramus of the lower maxilla is resected, the pterygo-maxillary fossa is entered, the petrous bone is trephined at or near the oval foramen, and thus the ganglion is reached.

In *Hartley's method*, or the *Krause-Hartley's method*, a large osteocutaneous flap is cut out in the temporal region; the dura mater is raised from the petrous bone to expose the ganglion, which is removed without injuring the motor root.

Ulcers of the face, when small, should be cocainized and curetted or removed with the knife. When the surface is deemed rather large and a marked scar apprehended, the spot should be grafted at once. When the surface is decidedly large, it is best to perform a plastic operation by the sliding process or by the pediculated flap when possible.

Extirpation of tumors should always be done from the interior of the mouth when possible: although more difficult, the advantage is that there is no external scar; when the tumors are small and the operation aseptic there scarcely should be a scar left.

Ligation of the external carotid on one side or on both sides will often give relief and temporarily arrest the growth of the tumor. If the two arteries are ligated, the ligations should be applied above the linguals. When the tumor is large and its removal compels that of a portion of the skin, the spot should be grafted or a plastic operation resorted to at once to close the solution of continuity.

In making incisions about the face care should be taken to make them in a direction that will spare the vessels, the nerves, and Stenson's duct; in one that will leave a less noticeable scar by following, when possible, the natural folds, grooves, and wrinkles of the face; by using thorough asepsis; a sharp thin-bladed knife; stopping hemorrhage thoroughly before stitching, so as to secure primary union; using fine needles, fine silk, collodion dressing, and slight pressure on the parts; using pins if much strain is expected on the sutures or if apprehensive of movement of the parts.

One of the serious difficulties of operating on the face and its cavities is the neces-
sity of often removing the face-piece through which the anæsthetic is being admin-
istered, so as to uncover the field of the operation and delay the operator. This
drawback and the consequent possible dangers are overcome if, after the patient

FIG. 84.
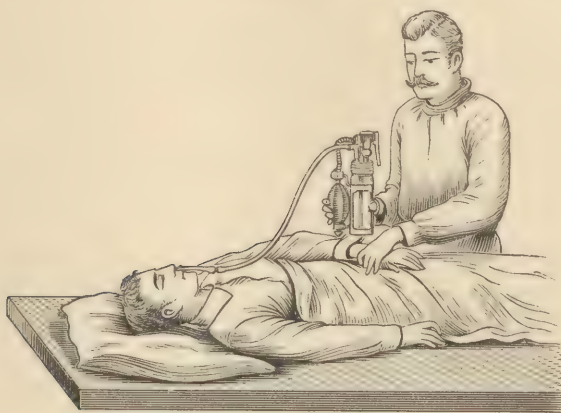
Souchon's intranasal inhaler.

has been fully anæsthetized by the ordinary method, a tube is passed through the
nose into the lower pharynx, and the anæsthesia is maintained uninterruptedly by
injecting through the tube the vapor only of the anæsthetic; thus a free field is

FIG. 85.
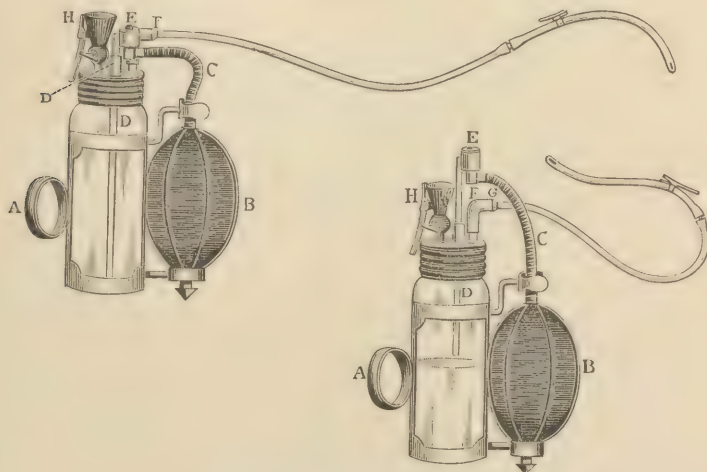
Souchon's intranasal inhaler.

secured. This is accomplished by an apparatus invented by the writer: it is so
constructed that it can be used with chloroform alone or with ether alone, or with
a mixture of the two: it is also provided with an attachment to connect it with a
bag of oxygen or nitrous-oxide gas if desired.[1]

[1] For detailed description see *Medical News*, Philadelphia, Nov. 23, 1895.

SURGICAL DISEASES AND INJURIES OF THE NOSE, EXTERIOR.

Congenital Malformations.—Fissures are more frequent on the ridge of the nose than anywhere about the face, and yet these are very rare.

Nasal dermoid fistulæ are always ascending, and may reach the dura mater.

Congenital absence of the nose has been observed by Maisonneuve : it was in a child nine months old. There existed only a flat surface with two small holes. Langenbeck recommends in these cases the transplantation of the periosteum of the frontal bone. *Occlusion* of the nostrils has been noticed. *Congenital clefts and fissures* of the nostrils are due to incomplete closure of the branchial fissures of the cheek or of the naso-genial fissures ; they are directed usually toward the external angle of the eye. Plastic operations are necessary to remedy the defect. A *bifid nose* due to a fissure between the lower lateral cartilages is recorded by Verneuil, Thomas, Borrelli.

Congenital hypertrophy has been observed.

Double noses exist ; they are more or less well formed. The remedy consists in removing one and closing the gap by a plastic operation. Sometimes the additional nose is a tumor.

Congenital deviations are more or less frequent, such as parrot nose, saddle nose, pug nose, excessive deviation to the right.

A case is reported of the successful removal of a morbid mass implanted on an abnormal bifurcation of the nasal bone, and in which was recognized the rough appearance of a fœtus : at the lower part of this fœtal mass, between its thighs, was noticed a penis, cavernous and erectile.

Acquired Malformations of the Nose.—Destruction of the nose is frequent enough as a result of injuries by ulcerations. A plastic operation is necessary to remedy the defect, or the wearing of an artificial nose supported by spectacles.

Closure of the nostrils follows burns, fractures, and small-pox : the contracted nostrils should be dilated gradually like other strictures ; the dilatation must be kept up so as to prevent recontraction.

Depression or *flattening of the bridge* may be due to fractures or to syphilis.

Rhinoscleroma is peculiar to the nostrils and to the skin around them : it begins by nodules in the cutis, which coalesce to form a hard growth with a smooth glistening surface, which spreads inward from the lip and downward to the pharynx : it is a very rare affection. It should be removed as early as possible.

Elephantiasis affects the nose markedly. Hypertrophy, pure and simple, is frequent enough. Hypertrophy of the lobule is not rare in those cases of acne rosacea where are found scattered hypertrophic conditions called "lipoma nasi."

Expansion or flattening of the bridge, or frog-face, is observed when tumors, originating inside, polypi, hernia cerebri, are growing to the outside.

Acquired deviations from blows, falls, causing fractures, dislocations of the cartilages or of the bones, are rather common.

Burns are grave because of the deformity that follows. It is important to keep the nostrils well dilated with tampons to prevent their closing ; it is also important to prevent scratching ; grafting must be resorted to in time when necessary.

Freezing of the tip of the nose is frequent in very cold climates. It is announced by a white discoloration : when vesicles appear, they denote an

unfavorable condition. The nose should be rubbed with snow at once; the reaction should be slow, lest the mortification be rendered inevitable or worse. The nose is sometimes the site of chilblains (erythema pernis).

Contusions of the nose are common.

Punctured wounds are rare. *Incised wounds* need no sutures unless the cartilages are involved: it is very important to properly approximate the edges, especially if the nostrils are involved, because a very small deviation makes an unsightly and ever-noticed scar. Should a piece hang or have been cut off, it should be thoroughly cleansed and reapplied, without stitches, by plates and light collodion dressing. *Contused* and *lacerated wounds* require also particular care of the nostrils: if a piece is detached, reapply it or graft in time.

Dislocations of the nose, cartilages, or bones require treatment similar to fractures. **Fractures** of the nose are usually due to severe blows or falls; fractures of the upper part of the nose require very great force.

Fig. 86.

Rhinoscleroma (Dr. Wende's case).

The direction is transverse, with backward displacement, if the blow be from above; it is lateral if the blow be from the side; in children it sometimes happens that the bones are fractured only in the middle, and are sunken in.

The SYMPTOMS are those of fractures in general.

The DIAGNOSIS may require an anæsthetic if there be much swelling, as a correct diagnosis is important before the bones begin to unite, which may occur before the swelling has disappeared.

The PROGNOSIS is serious, because of the probable and frequent deformity: very often much prominent deformity follows a fracture which at first was thought to be slight.

The TREATMENT must be directed toward replacing the bones and preventing deformity: the fragments should be replaced by using external and internal manipulations; internal aseptic tampons should be used with caution on account of the

possible sepsis.   Apply externally strips of plaster and compresses; in cases where the fragments fall back they should be raised and supported by passing a needle transversely between the fragments and the sound bone.

A complication that is not uncommon is emphysema if the lachrymal bones have been broken or if the mucous membrane has been lacerated: very often there is much bleeding, with persistent headache, even with concussion symptoms. The latter complication, if grave, may cause death.   The dreaded sequel of fracture of the nose is the deformity: sometimes the nose has to be refractured and readjusted; in some cases osteoplastic operations are required.

Poisoned wounds, stings, bites, present no special remark here, except, of course, glanders, which shows externally first by an inflamed and ulcerated condition of the nostrils and upper lip.

Erysipelas often first shows on the tip, coming from the interior of the nasal cavities.

Gangrene of the nose is rare : when it occurs, plug the nostrils to prevent strictures ; graft in time ; perform plastic operation to remedy deformity.

Reynaud's disease, described in connection with the face, sometimes affects the nose.

Necrosis of the bone is usually syphilitic, and should be treated as in other situations.

The *diseases special to the nose*, and not seen anywhere else, are— rhinoscleroma (Fig. 86), erythematous lupus, acne rosacea, acne hypertrophy (lipoma nasi).   The diseases that are most frequently met with on the nose are—naso-genial congenital fissure or fistulæ, bifid nose, deviations, strumous hypertrophy, frog-face, seborrhœa oleosa, frostbite, knock-out blows, glanders, erythema solare, Reynaud's disease, lupus exedens and non-exedens, epithelioma.   Scrofuloderma of the nose is represented by a peculiar hypertrophic nose and the peculiar eczema of the nostrils.   Tuberculoderma is represented particularly by lupus.

OPERATIONS ON THE NOSE.

Plastic operations for the repair of partial losses or for the construction of a whole nose are among the most delicate operations in surgery. The operation is called *rhinoplasty*, and comprises the Italian method and Indian method.

The *Italian* or *Tagliacozzian method* is named from Tagliacozzi.   It consists in making a pattern which is applied to the skin of the arm ; the skin is then incised all around it, but one-third more on every side for shrinkage ; a pedicle is carefully preserved ; the flap is raised, and is allowed to remain so for about fifteen days, when its lower edge is much thicker on the under surface and presents granulations.   Then the edges of the stump of the nose are pared, as also the edges of the flap, and the arm is brought in such a position as to allow the ready fitting of the flap to the nose, where it is properly stitched.   The arm is held in that position by a liquid-glass or a plaster bandage or by some special apparatus until union has taken place, when the pedicle is severed and the arm released.   The upper lip is used afterward to make the columna.

In the *Indian method* a pattern is also made, and is applied to the skin of the forehead, which is incised in exactly the same manner, but the flap is at once placed in proper position.   Care should be taken not to wound the angular artery. The gap created by the taking of the flap is closed by a sliding autoplasty or by grafting : it is sometimes advisable to raise the periosteum with the flap, or even the outer table of the frontal bone (König).   For the minute details of these operations the student is referred to special works.

Surgical Diseases and Injuries of the Lips.

Congenital Malformations of the Lips.—Absence of the lips, or *acheilia*, is very rare. *Astomia* is absence of the buccal orifice, which is different from the simple atresia due to excess of adhesions of the lips. *Atresia* of the mouth, when incomplete, is narrowing of the buccal ori-

Fig. 87.

Complete bilateral fissures (coloboma) of face (Guersant).

fice; when complete, it is also called imperfection: this differs from astomia in this, that behind the lips there is a buccal cavity. Incomplete atresia is also called phimosis of the mouth: sometimes the obliterated mouth is replaced by a congenital genian fissure. Atresia of the

Fig. 88.

Fig. 89.

Incomplete hare-lip (Bruns).   Complete fissure in double hare-lip (Bruns).
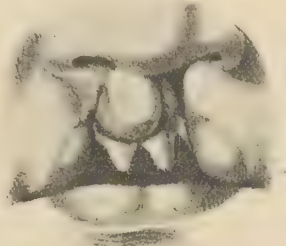
orifice of the mouth, without loss of substance and without adhesion of the jaws, may be called *ankylocheilia;* it is usually due to lupus, syphilis, variola; in one case the orifice was completely closed.

Congenital fissures all start from the lip; they present the following varieties: fissure of the lip alone, or prolonged fissures which extend

toward the face or the neck; the prolongation is sometimes a mere cica-tricial line looked upon as an intra-uterine cure of hare-lip. The hare-lip is simple when it involves only the lip; it is complex when it affects also the alveolar process or the hard and soft palates. The other varieties are the ordinary or vulgar hare-lip—*i. e.* a fissure under the nostrils; the *coloboma* or *bucco-orbital* fissure (Fig. 87), external to the wing of the nose; the *median fissure*, the *genian* commissure, and the median fissure of the lower lip. Commissural fissures constitute *macrostoma*; they are compound or associated fissures.

Congenital fistules of the *lower lip* are often represented by two small orifices symmetrically situated on each side of the frænum and opening on the free edge of the lip nearer to the mucous surface; sometimes there exists also a hideous ectropion of the lower lip, and also a transverse groove.

Median fissure of the *lower lip*, varying from an inch in width to a regular

Fig. 90.   Fig. 91.

Double hare-lip with philtrum or snout (Park).   Complete fissure, with labial defect and pro-jecting intermaxillary (Bruns).

groove, which may be prolonged as a continued line as low as the sternum; the lower maxilla may also be involved; also the tongue may be bifid.

Branchial fistulæ of the lips have been observed. *Atrophy of one lip,* causing tightness of the same or of both lips, is not uncommon. *Congenital microstoma,* or small mouth, is mostly due to arrest of development of the maxilla. *Macrostoma,* large mouth, or fissure of the cheek, is due to the lack of closure of the branchial fissures; the commissure is extended into the cheeks horizontally or upward or downward, on one side or on both sides. *Median fissure of the upper lip* is very rare on account of the peculiar development of the middle portion of the upper lip.

Hypertrophy of the lips is not infrequent. *Macrocheilia* is thick everted lip; it is a condition of lymphœdema. In the general hypertrophic form all the struc-tures are involved; the upper lip especially is affected; it may involve only the mucous membrane and form a sort of chemosis of the lip, or it may involve also the glandular layer and increase the appearance, or the whole lip may be involved; the mucous surface of the lip is covered with a rough, wrinkled mucous mem-

brane, presenting a separate pouch on each side of the median line. (*Vide* Chapter XXX. Vol. 1.) *Mucous ectropion*, or hypertrophy of the mucous membrane or extrophy of the lips, is usually congenital. *Congenital hypertrophy* is not uncommon in strumous subjects, especially of the upper lip. Macrocheilia is a special form of congenital hypertrophy of the lips; it is different from the big lip of the scrofulous, of cretins, of paralytics, of negroes: the cause is unknown; it is congenital; it is most common to the upper lip, whereas angeio-elephantiasis selects the lower lip. The alveolar border is also affected; the lip may be increased as much as 14 centimeters in length, 8 in height, and 3 in thickness. It is composed of fibrous tissue, hard enough to creak under the knife, with star-like cavities lined with epithelium and containing serum and lymphoid cells. *Hirsuties of lips*, or overgrowth of hair, is sometimes observed in females. The following depilatory is useful: 3 parts of prepared chalk to 1 part of sulphide of calcium; make a paste and apply with a brush; let dry and then brush off the hairs; they grow again and the process has to be renewed. The best mode of treatment

Fig. 92.

Illustrating the osseous (palatal) defect in complete fissures (Bruns).

is electrolysis by means of a fine needle, which is glided along the hair-root to the hair-papilla, which is then destroyed by the current. *Congenital deviations of the lips* in the form of eversion or ectropion, or inversion or entropion, are quite rare without hypertrophy. All these cases of malformation are remedied by incisions, excisions, with or without plastic operations more or less elaborate.

Fig. 93.

Projecting intermaxillary bone (Bruns).

Acquired Malformations of the Lips.—*Acquired microstoma*, or union of the lips and closure more or less complete of the mouth, has been observed after burns, injuries, ulcers and removal of tumors. Atresia of orifice of mouth, with loss of substance and adhesions to the jaw, is called *syncheilia*; it is the rule after cancrum oris. As a result of all these deformities there is constant dribbling of the saliva and dropping of the food during mastication.

Acquired macrostoma, or large mouth, is also the result of similar causes. Cicatrices around the mouth are observed in children affected with congenital syphilis, and they may also present a scarred or a fissured aspect at the angle of the lips and cheeks. Acquired deviations or distortions of the lips may be directed upward, downward, or outward; may affect one side or both; most commonly it is ectropion that is observed, due to cicatrices from burns, injuries, gangrene, ulcers, operations; sometimes the lower lip is thoroughly everted and is attached to the skin of the neck. All these interfere with speech and the proper retention of the saliva. *Acquired ectropion*, or eversion of the lips, may be paralytic, mucous, and cicatricial. Cicatricial ectropion of the lips is due to the retraction of a cicatrix. *Scars* of the lips do not grow small with age, but grow with the body; the conspicuousness of the scars make them doubly objectionable.

Chronic swelling of the lips, or hypertrophy, is usually due to chronic lymphangitis; the cervical adenitis increases the lymphangeiectasic condition by becoming an obstruction to the course of the lymph. *Chronic swelling of the lower lip* is more rare in scrofulous subjects, but in idiots, cretins, and paralytics the lower lip is always pendulous and moistened by the constant running of the saliva. It constantly exposes to air and cold its ulcerated mucous surface, all of which causes a chronic thickening. In cases of old rebellious indurated lips the excision of a V-piece is necessary. The diseases of the bones of the jaw also affect the shape of the mouth, and must be studied with them.

Injuries of the Lips.—*Burns of lips* by acids (nitric, hydrochloric, sulphuric), when on the cutaneous surface, are usually the result of a criminal attempt; when on the mucous border, they are due usually to suicidal efforts.

Burns of all kinds are followed by cicatrices, which are very disfiguring; practise early and thorough grafting. (*Vide* Fig. 24, Vol. I.) Frost-bite does not affect the lips as often as the nose, in spite of their exposed condition. Freezing or effect of cold on the lips is usually a crack on the middle line of the lower lip, especially in young or lymphatic subjects; it is sometimes the cause of strumous lesions of the lymph-nodes. Contusions of the lips are usually accompanied by a great deal of swelling; the ecchymosis is oftener submucous, which is due to the greater softness of the tissues there and to the action of the teeth.

Punctured wounds are rare. *Incised wounds* bleed very freely : when perpendicular to the fibres of the orbicularis they present great separation of the edges, and are followed by a cicatricial notch; when the artery is injured the hemorrhage is profuse, especially if the wound be near the commissure; torsion and suturing usually stop it. Wounds on the mucous surface bleed more freely, because the arteries are nearer the mucous membrane. It is most important to approximate the vermilion border properly; be careful to prevent notching : when the whole lip is divided through it is safer to use a pin suture. *Contused* and *lacerated wounds* are frequent; sometimes the injury inside inflicted by the teeth is great, without any outward sign. They often resemble an incised wound because the teeth cut through from the deeper surface. It is best to convert lacerated wounds into incised ones by paring the edges, thus preventing ugly cicatrices and keloids; sloughing wounds should be pared down and sutured as soon as the granulations are healthy.

Wounds of the lips with loss of substance, such as bites by a man in a scuffle, by dogs, by horses, are not rare, on account of the shape and position of the parts. Poisoned wounds, stings of bees, of spiders, of insects, are accompanied by great pain, swelling, and disfigurement.

Inflammations.—*Furuncles* and *carbuncles* are comparatively frequent, especially on the upper lip; the swelling usually affects the mucous side, and it is followed by protrusion of the lip, ulceration, and

ectropion. They are especially dangerous here on account of the complication of phlebitis of the facial vein, which may extend to the sinuses of the brain. Owing to the peculiar anatomy of the parts, carbuncles present a diffuse swelling, are hard, of a brawny dusky color; they spread rapidly; the lips are their site of predilection; they are often followed by simple strumous adenitis (not tubercular).

Gangrene of the Lips.—*Cancrum oris* is phagedenic gangrene of the corner of the lips and of the corresponding portion of the cheeks; it involves the whole thickness of the lips; it is observed in ill-nourished and weak, ill-fed children; it is often followed by great deformity; the jaws may be drawn down by firm cicatrices; in some cases there is also necrosis of the bones. (*Vide* Vol. I. Chapter V., Fig. 29.)

Ulcers of the Lips.—*Tuberculosis* of the free border of the lips is found in patients with lung tuberculosis; sometimes it is due to direct inoculation, due itself to a wound from a projecting tooth, contact of a pipe-stem, or puncture with a fork; it is characterized by an ulcer with a peculiar bottom, granular, edges not prominent, irregular, perpendicular, somewhat serpiginous; around it the mucous membrane is purple, strewn with yellow dots; the surrounding tissues are most usually indurated; the nodes may be affected. Tubercular lesions are rare, especially on the lower lip; it is usually due to the extension of the lupus of the face. Lupus of the upper lip has a tendency to invade and destroy the nose; it is often remarkable for the concomitant swelling. *Syphilitic ulcers* are comparatively common under the form of chancres, which are more common on the lower lip. Indurated chancre of the lip is the most frequent of the extragenital chancres, especially in women and children. It is due to direct contact with mucous patches of the lips by a kiss or by a bite in a scuffle, or by indirect contact with the fingers, pipes, spoons, glasses, etc. It often occupies the mucous surface. The forms peculiar to the lips are—the fissuric chancre; the commissural or the median formed by two tubercles growing away from each other: erythematous chancre and dwarf chancres are mere erosions, and are not recognized until the secondary symptoms show themselves. One lip may become inoculated with a chancre from the other lip; gumma of the lips may become indurated and resemble a chancre, but will present a depressed centre and no nodes. Labial chancres require a longer time to cicatrize than the genital chancre: it is said that syphilis thus contracted is more severe than the genital. Mucous patches are also common. The infection is due to auto-inoculation through bad habits, lack of cleanliness. When the ulcers occupy the corner of the mouth, look for syphilis. *Remains of hereditary syphilis*, early or tardy, have been observed especially on the upper lip; the lesions are those of sclerosis, with hypertrophy and ulcerative gummata. The disease resembles lupus very much. *Cancerous ulcers* take the form of *epithelioma*, which is the cancer of the lip, especially of the lower lip; it will be described separately farther on.

Tumors of the Lips.—Liquid hæmatoma is rare, serous cysts are rare, but mucous cysts due to the obliteration of a gland are not uncommon: they most commonly occupy the inner surface, and contain a thick, sticky mucus. Angeiomata, or erectile formations, are most commonly congenital; they may affect the skin, the subcutaneous tissues, or the whole lip; they constitute a serious affection when they

are large, owing to the great destruction of tissue required in their removal. Angeiomata of the lips are frequent; the lips are a point of election. When cured the fibrous induration may form an unsightly tumor.

Chronic abscesses of the lips are rare. Hæmatomata with clotted blood are seldom seen on the lips, on account of the matted condition of their structure. Sebaceous cysts are common, and present difficulty in their dissection. Dermoid cysts are seen occasionally. Lipoma is very rare, but is sometimes observed; it is lobulated, soft, fissured. Lipomata are not rare on the lower lip; the lining membrane over them is grayish or yellowish; some of them are very vascular, like

Fig. 94.
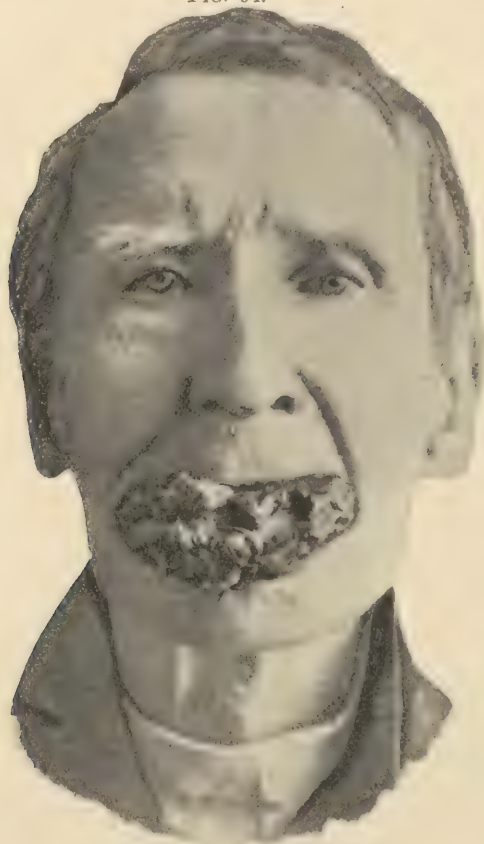
Fungating epithelioma of lip (Smith).

erectile tumors; adenoma has been observed. Syphilitic gummata are rare. Tertiary syphilis of the lips presents sclero-gummous lesions; circumscribed gumma of the lips is rare; it is seen more frequently on the upper lip; diffuse syphiloma of the lips is more common on the lower lip. In the rapid form the lip is fissured in two or three days, and swelling is present; in the slow form the progress is longer; it has a chronic course. *Papilloma*, mucous or corneous, has been described; also horny papilloma. Myxoma has been observed; also uncommon. Keloids are rather common on the lips. Neuroma has not been reported. Fibromata present three or four cases on record. Chondroma is rare. Osteoma is unobserved. Sarcoma is very rare. *Salivary cysts* of the glandules of

the lips are comparable to the grenouillette; they are more common on the lower lip. Some few cases of cysticercus are reported. Filaria of Medina, or filaria labialis or filaria hominis oris (Leidy), have been observed under the mucous membrane.

Epithelioma of the lower lip is a frequent disease in men, but rare in women. It is said to be often due to the irritation produced by a carious tooth, and most frequently by the contact of a short pipe-stem. Sometimes a chronic fissure resembling an ulcer is the starting-point. We must remember that an ordinary ulcer touched by a solid stick of lunar caustic will usually heal rapidly, whereas it has no effect on epithelioma, but sometimes stimulates its growth (Fig. 176, Vol. I.).

Epithelioma presents the following clinical forms and varieties, according to the size and character of the ulcer, to the condition of the adjacent lymph-nodes and the skin: It may be flat or superficial, presenting scales or an inflamed sebaceous outlet: this is the less grave form. It may be indurated or circum-scribed, with a raised edge, beyond which the tissues look and feel sound; because of this limitation this variety is the less objectionable. There is also a papillary form, with well-defined, non-indurated edges—and a diffused form, which resembles the condition of chronic inflammation, sometimes beginning by separate spots which coalesce, with elevation of the diseased part: this is the worst form, because it leaves the surgeon always in doubt as to whether he has thoroughly removed all the diseased tissues beyond the microscopically infiltrated or infected parts. It usually runs a more rapid course than the others. Epithelioma with nodes affected on both sides is of no very uncommon occurrence; with digastric nodes affected it is a very rare form; even when the whole lip is affected it is rare to find these nodes, which receive only the lymphatics from the middle of the lower lip.

Operations on the Lips.

Hare-lip should be operated early, but the health and strength of the child are more important than the age; the operation may be performed from the sixth week to the third month, but we must bear in mind that very young children do not stand bleeding well. Early operations are indicated especially in double hare-lip when the child

Fig. 95.   Fig. 96.
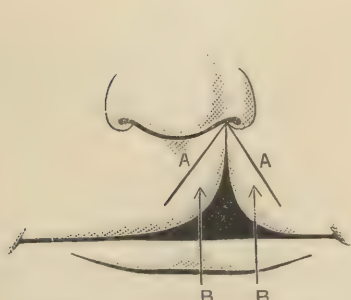
Malgaigne's operation: the incision.   Malgaigne's operation: the sutures in position; the lower sutures tied.
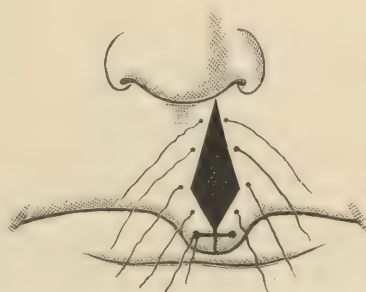
cannot suck if strong enough: no operation should be performed if there exists any sickness from dentition or other cause. The operation consists in paring the edges freely and bringing them together, and holding them with deeply buried pins and sutures. The pins should be

removed after forty-eight hours. In paring great care should be taken that no notch may remain after the operation. The accompanying plates explain the procedure most satisfactorily. For seventy-two hours after the operation the child should be fed with the spoon and also by enemata; opiates should be given for the pain.

Double hare-lip may be operated on in one sitting if not too extensive. In hare-lip with *projection of the intermaxillary bone* this bone should be pushed in, if possible; if not, it should be excised. Hare-lip with

FIG. 97.   FIG. 98.

Nélaton's operation: the incision.   Nélaton's operation: the sutures.
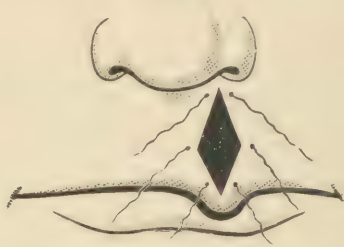
cleft of the hard palate should be operated early, as it will exert an approximating effect on the bones and will tend to diminish the fissure. In hare-lip with congenital fissure of the cheek the fissure should be closed at the same time. Hare-lip with deficiency or partial atrophy of the sides of the cheek calls for plastic and osteoplastic operations if the condition of the child allows; sometimes there is free bleeding from the artery of the septum; the orifice of the wound should be plugged. Hare-lip with general malnutrition is always grave, because the mal-

FIG. 99.   FIG. 100.
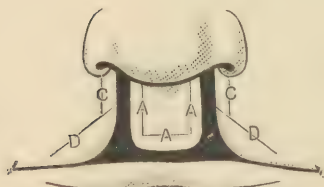
The operation for double hare-lip.   Operation for double hare-lip: the sutures in position.
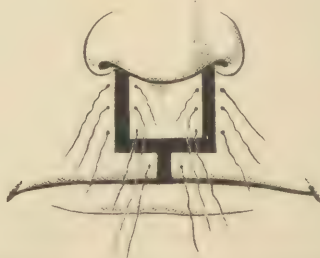
nutrition is often due to the defective condition of the lip, which interferes with nursing. Nutritive enemata should be used freely, and the operation performed as soon as the child's condition permits.

The principal operation upon the *lower lip* is the removal of an **epithelioma**. It is most important to operate early, before the nodes become involved; small or even large epitheliomata without lymphatic involvement may be cocainized and curetted, or excised.

The general principles of thorough asepsis must be observed here as everywhere else. An assistant compresses the inferior labial arteries;

with long curved scissors or with a knife the diseased parts are cut away, and spurting arteries are secured; a strong double silk suture is then passed through the upper part of each flap, and an attempt is made to approximate the parts, which manœuvre shows the extent of the loss of substance. If this be such as to require it, each flap is to be detached from the bone and partially from the cervical fascia in order to bring the edges together without strain. This approximation is best effected with pins and silk, because they resist the contraction of the muscles better than other kinds of sutures, which cut more easily under the involuntary movement of the patient. The mouth is usually very much puckered as a consequence of this suturing, but the tissues yield remarkably with time.

In very extensive disease the flaps must be detached from the bone and, if necessary, dissected as far back as the angle of the jaw and as low down as the thyroid cartilage, in order to be able to bring the sides together: the flaps must consist of the skin and platysma, and the line of dissection should be the layer of connective tissue between the platysma and the cervical fascia. Sometimes regular plastic operations must be performed. In epithelioma with lymphatics adherent to the bones, these must be well scraped and even cut away. Where union has once failed one should wait until the tissues are thoroughly removed, because primary union may fail again. Epithelioma recurring on the lips or in the nodes must be operated on at once; it is the last and only chance.

Cheiloplastic operations—*i. e.* plastic operations on the lips—are performed for restoration of the upper or lower lip or for deviations of the angles. They consist in sliding flaps with a pedicle, or in transplanting

Fig. 101.   Fig. 102.
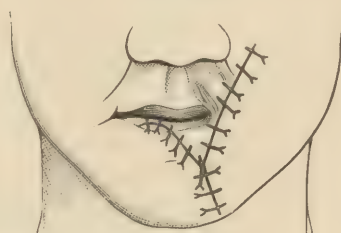
Estländer's cheiloplastic operation.

flaps from the neck and face: these flaps must be muco-cutaneous—that is, formed of skin on one side and mucous membrane on the other. Skin-grafting is often of useful assistance in filling gaps.

Surgical Diseases and Injuries of the Chin.

Congenital Malformations.—*Absence of chin* is a possible malformation due to an arrest in the development of the parts, especially of the bones.

Congenital atrophy of the chin, as well as *double chin*, is observed as the result of an incomplete fusion of the two halves of the face; an accumulation of fat causing thick folds under the chin is also called double chin. Congenital *deviations* forward, or *galoche* chin, or laterally, are not uncommon.

Hypognathy is a malformation characterized by the implantation of a supernumerary inferior maxilla by its own symphysis on the symphysis of the subject:

the implanted maxilla is a real one, having the same shape, more or less, and containing dental sacs. Sometimes the implantation is bony (myognathes), or is only soft and loose, or it may be pediculated (dermiognathes). It is a tumor of unequal density, here bony and hard, there soft; cysts may develop in its interior and attain great development. It may grow toward the chest, the mouth, or the neck.

Injuries of the Lips.—*Burns* of chin present nothing peculiar; nor does frost-bite, except in its greater frequency because of the exposed situation. Suicidal attempts at shooting beneath the chin seldom kill, because the patient usually throws his head backward while the pistol is directed upward: they usually result in the destruction of the lower lip and under portion of the inferior maxilla.

Indurated chancre of chin is mostly due to a barber's wound with a contaminated razor: it is often scabby in that region. Fistulæ and tumors of all kinds are comparatively rare and present nothing special.

Surgical Diseases and Injuries of the Cheeks.

Congenital malformations and branchial fissures, resulting from the lack of union of the branchial arches, are not uncommon. They may be horizontal or angular; they may be vertical when the failure of union is located between the extremities of the branchial lamina and the frontal bud from which the nose and the middle of the upper lip are developed; they may be unilateral or bilateral.

Congenital fistulæ have been observed on the cheek exceptionally. Congenital salivary fistulæ, due to a similar mode of production, are on record. There is no recorded case of absolute absence of the cheek. *Congenital atrophy* of the cheek is marked by a considerable sinking of the region; it may be due to a want of development of the bones, the teeth, or the ball of fat that exists between the masseter and the buccinator. *Congenital deviations* are sometimes observed at birth as a result of the paralysis of the facial nerve due to the pressure of the forceps or to purely structural changes. Swellings of the cheeks are most commonly caused by a bad tooth; the next most common cause is an abscess of the antrum.

Injuries of the Cheeks.—Contusions are not rare: when they involve the malar and frontal bones they are said to be followed by amaurosis, due not to reflex action, but to injuries (detachments) of the lens, iris, retina, or choroid, or to extravasation of blood in the chambers of the eye. *Burns and frost-bite,* extending to Stenson's duct and to the facial nerve, are followed by salivary fistulæ and paralysis of the face. Punctured wounds present nothing peculiar unless they pierce the facial artery or vein or Stenson's duct. Large perforating wounds may leave a permanent fistulous opening through the cheeks.

Wounds of Stenson's duct must be attended with solicitude to prevent a fistula; they are more rare than those of the gland, being protected by the malar bone and zygoma. The division is usually complete; they are followed by the escape of saliva; if union fails, there occurs a fistula or a salivary tumor between the two divided ends, which fills at meals and empties after by pressure; obliteration of the canal and atrophy of the gland may follow. In recent wounds stitch the duct ends together; in old wounds introduce catgut in distal end; then press on the parotid to discover the proximal end, and stitch it to the catgut of the peripheral end. The wound should be enlarged if necessary, and the proximal end curved into the interior of the mouth and retained there by sutures. (*Vide* below.)

Wounds of the branches of the *facial nerve* should also be stitched if possible: although the branch may be small, yet if paralysis should

follow its injury, the result may be most serious, especially if it be the branch distributed to the orbicularis of the eyelids. *Fractures of the malar* or of the *zygmotic arch* are rare, because very great force is required to produce them: most commonly the arch is broken and depressed. It should be raised by means of a narrow lever. If the fragment be loose and falls back out of place, it should be raised with

Fig. 103.
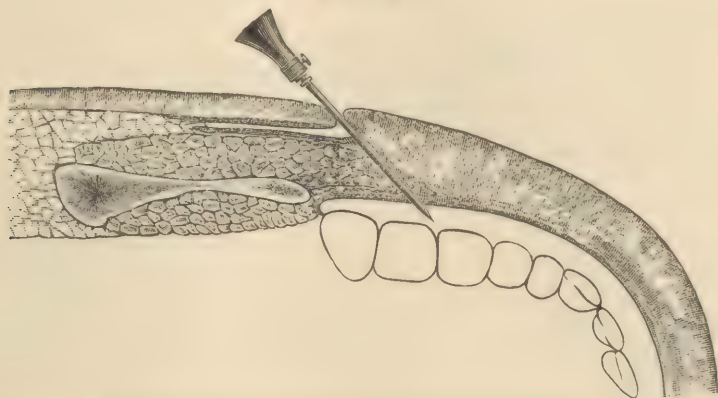
Salivary fistula: treatment by single puncture (Hartmann).

two or three silver sutures passed under it and tied over a sterilized small aseptic splint placed over the extremities of the facial bones.

Inflammation of Stenson's duct is called sialo-ductilitis: it is more rare than that of Wharton's duct. Bristles, fish-bones, straws, tooth-brush hair are the usual causes; it is sometimes due to propagation through

Fig. 104.
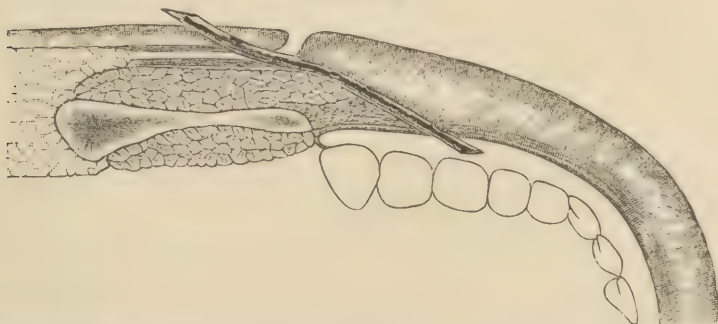
Salivary fistula: Richelot's method by double puncture and insertion of drainage-tube (Hartmann).

the mouth; there is swelling of the gland, abscesses, fistulæ. Fistulæ may be due to carious teeth or bone.

Fistula of Stenson's duct is usually situated on the buccinator: the orifice is narrow and in the centre of a granulation or in the midst of cicatricial tissue; a viscous fluid is discharged, increasing during mastication. Lymphatic fistulæ of the region are rare; their outpour does

not increase during meals; the liquid coagulates; sulphocyanide of potassium is absent from it. Fistulæ of the *parotid gland* are recognized by exploring with a probe from the mouth.

The TREATMENT consists in the cauterization of the orifice, its compression with collodion to produce occlusion, or in operative closure. These measures are good if the peripheral end is pervious; if not, we must re-establish the course of the saliva toward the mouth by re-establishing the normal canal, which is difficult.

FIG. 105.

Salivary fistula placed anteriorly to border of masseter; double puncture of mucous membrane and enclosure of portion in a wire loop; fistula thereby made internal (Hartmann).

One operates from within the mouth by passing a threaded needle around the duct back of the fistula, penetrating and coming out as nearly the same point as feasible, having the duct in the loop, but leaving out the skin, then tightening, or by single puncture and drainage when the fistula corresponds to the anterior border or occupies the region of the masseter. When the course of the saliva is re-established, then the fistula is pared and closed. Other means are—causing atrophy of the parotid by compression or by ligation of Stenson's duct behind the fistulous orifice, or by injection of oil or iodine into the duct: this is very successful on the horse; it never cures in man. (For other methods see Figs. 103, 104, 105.)

·**Tumors of the Cheeks.**—Cysts of Stenson's duct and dermoid cysts have been observed near the parotid region, in the depth of the cheeks, or in the course of the infundibuliform fissure.

Angeiomata of the fatty ball of Bichat are usually well circumscribed, stationary, and may obliterate Stenson's duct and be accompanied by parotidean lithiasis; the superficial veins are dilated. Lipoma of the fatty mass of Bichat usually becomes superficial in the cheek in front of the masseter or malar bone, or submucous when the yellow coloration is sometimes seen; sometimes it ascends under the temporal fascia.

Sarcomata of the fatty ball of Bichat have been observed; they grow backward. Angeio-sarcomatous cysts of the cheek have been observed over the masseter. Salivary colic is sometimes observed, due to the passage of a calculus through Stenson's duct.

Diseases of an Accessory Parotid.—Tumors of the cheek sometimes originate from an accessory parotid gland or from Stenson's duct. Cysts with a glandular epithelial lining are forms of grenouillette of the accessory parotid.

CHAPTER V. (*Continued*).

SURGICAL DISEASES AND INJURIES OF THE NECK.

By Edmond Souchon, M. D.

Congenital Fistulæ of the Neck.

These are due to arrest of development or lack of fusion of the branchial laminæ or folds and clefts of the pharyngeal fissure; they are sometimes hereditary, but are sometimes discovered only a long time after birth. They may be due there to a cyst which has ruptured externally. They are usually very small, seldom admitting more than a case probe, exceptionally the end of the little finger. The external orifice is situated most commonly on the right side of the neck in front, and behind the sterno-mastoid, and between the thyroid cartilage and the sterno-clavicular articulation; sometimes, but rarely, at the angle of the jaw; it is sometimes on a projection, at other times in a fold of the skin; it occasionally presents cartilaginous or osseous particles; it may be found blocked by the dried secretions. These fistulæ resemble congenital tracheal fistulæ, but open less commonly on the middle line; they are rarely found on one side, and still more rarely on both sides.

The internal orifice may open into the pharynx or larynx or trachea: it is observed almost always near the tonsil and base of the tongue, and is very small; it may become the starting-point of serious inflammation and abscess. When complete an injection of milk penetrates the pharynx or the larynx. These fistulæ may be externally or internally blind: the externally blind are by far the most frequent. The course of the fistula is marked by a cord-like-tract which corresponds to the tract of the fistula; its direction is straight or tortuous, oftenest in the direction of the great horn of the hyoid bone; it is constituted by an external thick, fibrous coat which forms the cord and is lined by a sort of mucous membrane which secretes a thin, viscid fluid containing epithelial cells or puruloid. Internal blind fistulæ are very rare, but positively exist. They present the variety called diverticula "by pulsion" of the pharynx and œsophagus, due to the dilatation and development of an originally small pouch under the influence of the accumulation of the food; they sometimes form very large tumors. The diagnosis of congenital fistulæ rests upon the secretion of the fluid, the presence of the cord, the penetration of the probe, and the injection of colored fluid. Congenital fistulæ are almost always stationary; the lesion is more of a deformity than a disease.

Treatment is usually unnecessary, and fortunately so, because it usually fails when limited to stimulating injections, dilatation, or curetting, and excision is a laborious operation, not without danger, and scarcely justified by the inconvenience experienced. Both orifices may close and leave an intermediate tract.

Congenital atrophy of the whole or of more or less extensive parts of the neck is very rare without participation of the rest of the body. *Congenital atrophy of the sterno-mastoid* has been observed.

Contusions are not frequent: they are usually produced by falls, blows, hanging, garotting, throttling, passage of a wheel over the neck, or by the pressure of the dislocated clavicle. A blow on the side of the neck

is a great aim with pugilists, because it is almost a sure knock-down or knock-out ; it is often grave, because of the importance of the organs of the neck, and may be accompanied by fracture of the hyoid bone, larynx, and trachea, injuries to muscles, vessels, nerves, pharynx, œsophagus, vertebral lesions, concussions and contusions of the spinal cord. A hæmatoma may form and become large, and cause grave pressure symptoms on all the structures.   Death may occur after a few days from œdema of the lungs, also from embolism from one of the large vessels of the neck.

Wounds of the neck are comparatively rare in civil practice ; sometimes they are accidental, and due to a fall on a fragment of glass, a stem of iron or of wood ; they are most commonly due to attempts at murder or suicide ; the latter are the most common and most instructive.

Superficial or *extrafacial wounds* of the neck—*i. e.* wounds not extending beyond the superficial cervical fascia—present nothing peculiar. However, a large incised wound of the external or anterior jugular, especially if it happen to be unusually large, may give entrance to air.   In tracheotomy the anterior jugular is often wounded ; also the inferior thyroid veins.   If the parallelism of the lips of the wound has been disturbed, there may be much infiltration of blood : this requires enlargement of the incision and ligation in preference to pressure ; cellulitis spreads rapidly.   Gunshot wounds are rare, yet there are instances where a bullet has travelled under the skin and above the fascia without penetration of the fascia.   Contused and lacerated wounds, if extensive, may be followed by cicatrices and their consequences.   Gunshot wounds causing much destruction of skin present the same marks as the lacerated wounds.   *Deep* or *subfascial wounds* are almost all very serious, because of the almost constant injury of some of the large vessels and nerves or of the special organs of the neck—larynx, trachea, pharynx, thyroid body—giving passage to air, food, blood ; each of them calls for appropriate treatment.

The SYMPTOMS of **entrance of air into the veins** are a wind-sucking or gurgling sound, immediate pallor of the face, dilatation of the pupil, irregular or tumultuous action of the heart, embarrassed breathing, and sometimes death.   The wound should be plugged at once with the finger, and all the usual means of resuscitation vigorously and persistently applied.   The amount of air introduced is a grave factor. If the wound be small, the operation may be continued by keeping it constantly filled with **warm sterilized water.**

Dislocations, also *sprains*, are the result of injuries in which the head is much stretched, most commonly and especially when violently striking an obstacle, vertex first : they give rise to great pain, particularly when the head is thrown backward.

The TREATMENT consists in thorough rest of the part by lying on a bed or by applying a liquid-glass bandage.

Poisoned wounds—*i. e.* bites, stings—are more frequent on the neck on account of its exposed condition ; also more grave, because no clothing has protected the parts ; also, because they are usually followed by great swelling, which, reaching the aryteno-epiglottic folds, causes obstruction of the larynx.

In all injuries of the neck causing obstruction to the free circulation of the air, from whatever cause, there are great dyspnœa, cyanosis, anxiety ; the pulse is full, rapid ; there is also aphonia, dysphagia, pain. Tracheotomy should be performed : it is often advisable not to wait for very urgent symptoms, because death may come on rapidly or suddenly before the patient can be reached to have the operation performed.

Cellulitis, deep or subaponeurotic, is a very grave affection, because of the compression due to the swelling, and because these symptoms are increased by the unyielding nature of the fascia. It may be primary, the result of cold, or secondary, due to some injury or some lesion of the teeth, especially of the wisdom teeth, bones, lymphatics, thyroid body, scalp, ear, face, mouth, or to low fevers. It may come from neighboring organs : tonsillar abscess sometimes opens under the inferior maxilla, and deep axillary abscess in the supraclavicular region, as may also an anterior mediastinal abscess.

Abscesses following injury or *scarlet fever* sometimes form a hard mass, slow in suppurating, causing great damage ; sometimes they bleed alarmingly when opened or even after they have been opened several days, on account of sloughing of the vessels ; they may be accompanied by thrombi in the large veins or sepsis. When the cellulitis suppurates, the abscess may be circumscribed or diffuse ; the pus may fuse in the chest, in front of the thyroid and sternum (*previsceral route*), behind the pharynx and œsophagus (*retrovisceral route*), or along the carotid and jugular vessels in their sheath or in the sheath of the nerves of the brachial plexus behind the sterno-mastoid, reaching the supraclavicular region and the axilla ; it may open into the pharynx, œsophagus, larynx or trachea, pleura, mediastinum. *Retropharyngeal abscesses* may be limited : then they project on the sides of the neck in the maxillo-pharyngeal space ; when they are median they can be reached through the mouth. In some subacute cases, in the upper cervical region and at the root of the neck, abscesses have a tendency to become encysted, and finally open on the skin ; they may be chronic. When an abscess is near or over the carotid, it pulsates, but there is no expansion.

The DIAGNOSIS of deep abscesses, especially of the acute abscesses, should be made at once by using the exploring needle and syringe—not a hypodermic needle, which may not give passage to thick pus, but a needle at least twice as large as an ordinary hypodermic needle. Exploration should be repeated every second day if necessary.

The TREATMENT is of course evacuation and drainage, but in these dangerous regions fear of wounding important structures often holds the surgeon's hand when the abscess is one or two inches deep, until it becomes more superficial.

By incising in the middle line and going around the trachea the knife can penetrate deeply with safety ; also by incising behind the posterior border of the sterno-mastoid, and along the base of the jaw. It is recommended by some to cut down and ligate the vessels as they are divided, but when these are imbedded in indurated tissue it is almost impossible. Others leave the needle in place and cut down along it, but the divided vessels present the same dangers and difficulties. Hilton's method is to use the knife only to start, and as soon as deep parts are reached to tear with the director and use dressing-forceps to dilate the small entrance gained into the abscess : it presents the same objections. The writer's method he calls **guided dilatation**. It consists in the following steps : Use a proper needle, as above described, to locate the pus at the depth of one, two, or

three inches; unscrew the syringe and leave the needle in place; introduce through the needle a steel wire seven or eight inches long, until it reaches the bottom of the abscess; remove the needle, leaving the wire in place; make a small incision through the skin to overcome the only serious resistance to the introduction of the dilators; take a trocar (with cannula) of one-eighth of an inch in diameter, perforated from point to handle, and run it over the wire into the cavity of the abscess. It penetrates by dilating the tissues by the three blunt edges of its prismatic triangular point. Then remove this trocar, leaving the wire still in place; take a trocar and cannula of three-sixteenths of an inch and introduce it likewise along the wire; withdraw the second trocar, and insert in a like manner one of a quarter of an inch; then one of five-eighths; finally withdraw the trocar and the wire and leave the cannula in place; through the cannula introduce a drainage-tube of a quarter of an inch in diameter; remove the cannula, leaving the drainage-tube in place. A suitable probe can be introduced through the drainage-tube, and a counter-opening made at the proper place. After forty-eight hours the opening can be safely dilated to a half inch or more if it is found that the quarter-inch drainage-tube is not sufficient.

By this method the tissues are not cut, but simply uniformly pushed aside; there is no cutting at any time, since the edges of the triangular point are blunt : a round or conical point sometimes packs the tissues and does not penetrate. If a vessel or a nerve is encountered, it is shoved

FIG. 106.
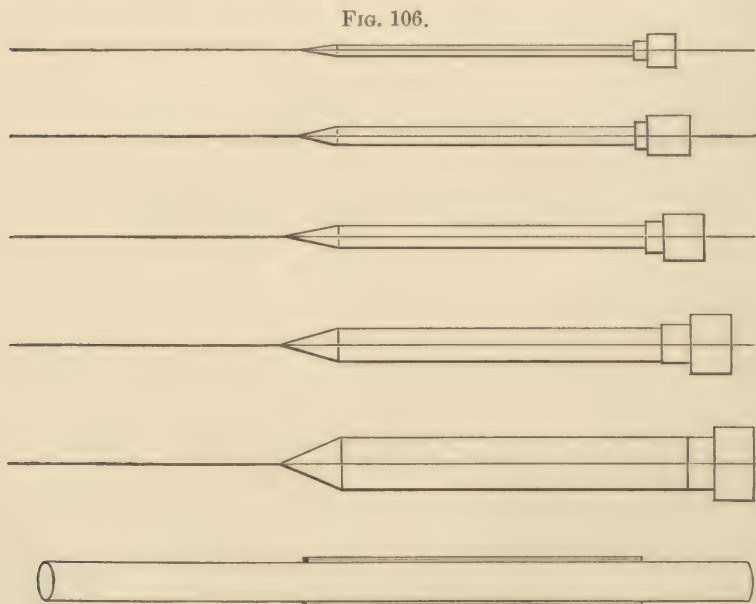
Guided dilatation in evacuating abscesses.

gently aside out of the way : that is one reason why the dilatation should be gradual, and why it is not advisable to pass from a one-eighth to a five-eighths trocar. There is no difficulty experienced, as far as the introduction is concerned, in passing from the smallest trocar to the largest. (Vide Fig. 106.)

Fistulæ of the neck are rare. The *tracheal* are the most frequent, and are oftenest due to incomplete transverse wounds and to the retraction and stricture of the lower end : sometimes they result from the removal of parts of the tracheal cartilaginous rings in thyroidectomy;

sometimes to tracheotomy. They may be congenital, but it is rare. Alimentary fistulæ communicate with the œsophagus or the pharynx, and are called œsophageal or pharyngeal : they are usually the result of accident or surgical wounds or follow the opening of extensive abscesses.

In old fistulæ the orifice is circumscribed by a cicatricial ring intimately adherent to the edges of the loss of substance of the trachea ; they demand an autoplastic operation. Plastic operations are necessary to cure many of those fistulæ which remain after the removal of the original cause, and after the dilatation and curetting of the tract.

Tumors of the Neck.

Aeroceles (*laryngoceles, tracheoceles*) are tumors formed by air filling an adventitious pouch : this excludes pneumatocele. The predisposing causes are weakening of the tract and emphysema. The occasional causes are strains (cough, labor). Some are congenital dilatations of the laryngeal ventricles, abnormal prolongations ; some are traumatic and due to wounds of the trachea, rupture of the intercartilaginous spaces ; others are pathological, due to dilatations of the glands of the mucous

Fig. 107.

Bilobed multilocular cyst of neck (Lannelongue).

membrane, to ulcerations, syphilitic or due to former disease of the cartilages, or to abscesses. The course varies ; they are usually persistent. The *palliative treatment* consists in *compression.* In some cases extirpation is possible.

Pneumatocele is due to hernia or great protrusion of the lung into

the supraclavicular region : it is recognized by percussion and by its disappearance upon pressure and its quick reproduction by forced expiration. Pneumatocele follows the respiratory movements.

Cysts of the neck are of several kinds, and are known under the following names : mucoid cysts (Lannelongue), branchial cysts, deep dermoids, deep atheromatous tumors, congenital hydroceles of the neck, hygromata, atheromatous cysts of the lymph-nodes. They are almost all rare and congenital ; but they are not all *branchial*. They are situated along the course of persistent obsolete tracts lined with epithelium, in

FIG. 108.

Congenital multilocular serous cysts (hydrocele) of neck (Lannelongue).

the neighborhood of the pharynx and larynx, and along the large vessels ; they often have prolongations adhering to the muscles, the vessels, the thyroid cartilage, and hyoid bone, and even the vertebral column ; they may be single or multiple, resembling a bunch of grapes. They may take a sudden and unexplained rapid course and become very large (Fig. 108).

Serous cysts have been confounded with dermoid, mucous, or branchial cysts, although they do not, like those cysts, occupy a definite region corresponding to the branchial fissures : the neck is their seat of

predilection, and they serve as a type of their kind. When they are single or unique, they are almost always on the median line and on the left side; they occupy principally the antero-lateral surface of the neck (Fig. 108).

Sebaceous cysts or atheromatous cysts are only truly such when the dermoid structure of the cyst-walls can be demonstrated. They may attain the size of a fist; when lateral, they occupy mostly the region of the sterno-mastoid; when median, they occupy mostly the supra- and infrahyoid regions.

Sanguineous cysts are at times connected with the anterior jugular vein; they contain a reddish fluid, which characterizes them upon exploration; occasionally they remain in connection with vessels. They

Fig. 109.
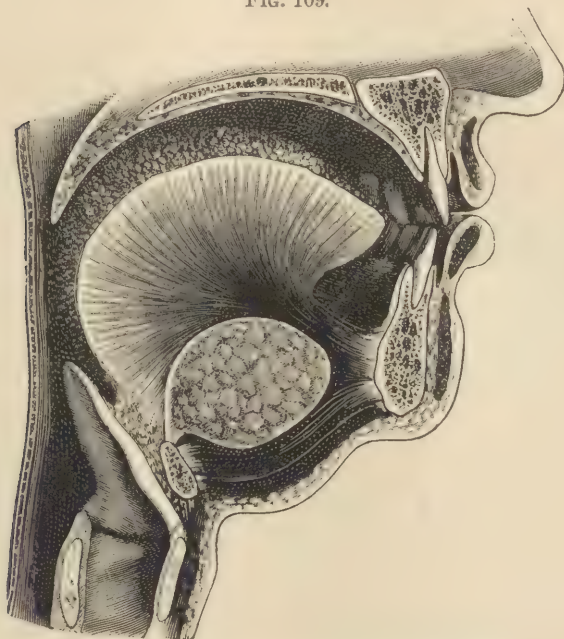
Dermoid (ad-hyoid) cyst at base of tongue (Marchant).

are emptied by pressure, but they refill rapidly; they must not be taken for aneurisms when the vessels impart pulsations to them. Hemorrhagic sanguineous cysts are due to intracystic hemorrhage. Punctures and incisions are sometimes followed by intracystic hemorrhage, which may ultimately end fatally.

Dermoid cysts are frequent here: the cyst may be attached to the trachea. These cysts are not bursal cysts: the epithelial lining shows they are congenital. They are all congenital, but they may not become manifest except at a later period, especially at puberty. Lateral branchial cysts usually occupy the region of the sterno-mastoid. Median branchial suprasternal cysts sometimes penetrate into the mediastinum. Median thyro-hyoid cysts often take on a rapid growth at puberty or after a confinement: they are often opened by mistake, and this is followed by a persistent fistula with mucous secretions (Fig. 109).

Fibroma is rare; it rises from the fibrous layers. **Congenital branchial fibro-chondroma** of the neck is seen in all regions of the branchial arches. It occupies almost always the external orifice of a congenital fistula, a little above the sterno-clavicular articulation. Myxoma and myoma are rare: one case of chondroma is on record, following chondroma of the scapula. Those independent of parotid and lymphatic nodes are very rare; some tumors are very large; they may adhere to the vessels and to the deep structures (Fig. 110).

Fig. 110.

Enormous diffuse lipoma of neck (Jeannel).

The condition of the skin is important to determine: when distended by a large tumor a portion of it must be dissected along with the tumor to prevent redundancy of the flaps; when the skin is adherent, it should be also removed. The tumor margins must be next delineated: when circumscribed or limited, it is a favorable sign, because the tumor will be easier to remove along a well-determined line of dissection with safety and in its entirety; when the margin is diffused, it is a most unfavorable feature, because of the uncertainty of the line of dissection and the absence of all certainty of removing all the involved parts.

The non-adhesion or the adhesion of the tumor to the bones is important to determine: when the tumor is movable, it must be determined whether it is clear of the important structures—*i. e.* if the vessels, nerves, and special organs.

It is prudent also in those cases to endeavor to locate the large vessels and to pass a provisional ligature under them before dissecting too close to the dangerous points. This provisional ligature is removed after all the bleeding has been controlled, or it may be decided to convert it into a permanent one. When the tumor is adherent to the bone, if it be clear of important structures, it is again favorable, as it may be enucleated with little risk.

Infrahyoid Region.

Congenital Malformations.—It is in the lower part of the region that the orifices of the branchial congenital fistulæ of the neck are most frequently met, near the head of the clavicle; they may also be met in the thyro-hyoid region.

In hanging the compression very often bears on the base of the tongue, and the larynx, vessels, and nerves are not injured. In strangulation the traumatism is applied upon the larynx and the trachea, which may be torn by the fingers or the rope; all the structures are more or less torn. In some cases lesions of the skin of the neck, of the trachea, and of the larynx may cause inhibition of the heart, of the respiratory organs, and of the brain. It is especially in cases of traumatism of the anterior region of the neck that we observe a complete loss of consciousness and a respiratory and cardiac syncope. This is what takes

place in cases of death through incomplete hanging, which does not prevent the passage of air through the respiratory passages. In such cases the red blood of the arteries continues red in the veins, whereas in death by true asphyxia the blood becomes rapidly black in the arteries.

Suicidal wounds are the most frequent; they are seldom punctured but are usually incised wounds; are most frequent at the point of the thyro-hyoid ligament or below it; they are lacerated, jagged, and deeper on the left side, and are usually directed from left to right and obliquely downward or transversely across the neck; the large muscles are seldom injured. Usually the suicide, throwing his head back, cuts too high; the trachea and the rigidity of the sterno-mastoid protect the vessels. If the head is too bent, the larynx, the trachea, and the sterno-mastoid also protect the vessels. There is usually a single gash. These wounds are more commonly fatal than the other wounds, because the victims are usually intoxicated or are laboring under delirium tremens or insanity: these patients should be watched closely, because they often tear away their dressings and die of hemorrhage. These wounds sometimes present much hemorrhage, although none of the larger vessels are hurt, except the anterior jugular vein: there are cases on record where air has penetrated into it and to the heart, causing death. The edges of these wounds are often much separated and have a tendency to roll in, on account of the action of the fibres of the plastysma; coaptation therefore needs more care.

Penetrating wounds above the larynx are less dangerous than those of the larynx and of those below it; the lower the wounds the more dangerous they are. *Wounds through the thyro-hyoid membrane* penetrate into the pharynx, injure the epiglottis, the aryteno-epiglottic folds, the cartilages, the vocal cords; they are less dangerous than below, because they allow feeding; they are more liable to suppuration. *Wounds of the larynx* are comparatively frequent, because of its prominence: they are usually very dangerous; they are also easily diagnosed by the rushing sound of the air passing through. They should be treated like those of the trachea. *Wounds of the trachea* are commonly followed by great hemorrhage, because of the large vessels around it, which may also have been wounded by the same cause. When the severance is incomplete, there is slight gaping; when the section is complete, the lower end is drawn in deep at each effort of inspiration, and the soft parts cover up the orifice, causing suffocation. In all cases keep the blood and foreign substances out of the respiratory tract until hemorrhage is checked. Rose's position may be of assistance. In incomplete wounds there is slight gaping, and the wound should not be stitched; the head should be flexed on the chest and fixed in that position by a liquid-glass bandage. In complete wounds, when longitudinal, there is little gaping. In complete transverse wounds the retracted lower end should be searched for and a strong thread passed deeply through it. An attempt at stitching should be made; if it fails, a tracheotomy-tube should be placed in it; the tube should be longer than the ordinary one, because the swelling may lift it out of the trachea; the head should also be kept flexed; a moist cloth should be placed over the tube; the room should be kept warm, at about 70°, and a vessel with boiling water should keep the atmosphere moist—all this to avoid bronchitis and

pneumonia.   Later we should be mindful of the exuberant granulations, which may obliterate the canal.

Wounds of the pharynx and œsophagus are usually made through the side of the neck by balls, knives, etc. ; they cause much pain, spasm, hiccough, dysphagia, more or less suffocation ; there is escape of food through the wound if this be of a certain size ; the thirst is great ; the patient should be fed by enema ; if the use of the œsophageal tube becomes necessary from insufficiency of the rectal alimentation, it should not be left in place, but introduced each time.   In incised wounds stitch immediately ; in lacerated wounds let the wound granulate.

Penetration of the respiratory tract is recognized by cough, bloody expectoration, hissing or boiling sound.   The secondary dangers are inflammation of the larynx, œdema of the glottis, bronchitis, pneumonia, abscesses and purulent dissections, emphysema, aphonia more or less complete, dysphagia : secondary hemorrhages are common and serious complications.   In all injuries with solution of continuity of the mucous membrane the most frequent source of death may be due to mediastinal emphysema and inhalation pneumonia.

Wounds of the neck parallel to the longitudinal fibres of the muscles are more apt to be followed by emphysema.   The remote effects and sequels may be exuberant granulations, causing dyspnœa ; cicatrization, producing strictures of the larynx, trachea, and œsophagus ; persistent fistulæ ; paralysis, due to inflammatory thickening, which may disappear later, or due to injury of recurrent nerves or the pressure of a bullet.   All these complications should be treated here as elsewhere.

Dislocation of the hyoid bone is very rare.   There is one case (Gibbs) in which the dislocation was muscular : it was accompanied by a peculiar click on the left side of the neck and a sensation of choking ; examination showed displacement of the left horn of the hyoid bone ; reduction was effected by throwing the head backward toward the right side, so as to stretch the muscles of the neck, and then suddenly depressing the lower jaw, thus bringing the depressors of the hyoid bone into action.   All the following fractures are usually due to violent contusions.

Fracture of the hyoid bone is rare, but it is well known ; its site is usually the great horn, near the body ; it may be unilateral or bilateral ; it is characterized more or less by hoarseness and dysphagia, according as it is without or with displacement, and without and with deformity.   It is accompanied by more severe symptoms, especially when swallowing fluids, which pass into the larynx because of the imperfect action of the epiglottis ; it is reduced by using the fingers inside.

Fractures of the larynx are less rare than fractures of the hyoid bone ; they are due to great violence ; they are usually accompanied by much pain and suffocation, often calling for immediate reduction or for tracheotomy.   Each cartilage may be fractured by itself ; the thyroid is most frequently the site ; fractures without displacement are not so grave.

Fracture of the thyroid cartilage is more common in old people, because of the ossification of the cartilage.   Fracture of the cricoid is more dangerous than others, perhaps because of its small size, which causes slight displacement to be followed by serious obstructions.

Fracture or subcutaneous rupture of the trachea without actual wound has been observed after great traumatism ; they are less frequent than the others ; they present the same symptoms and indications as the fracture of the larynx, but the lesion is lower down. The trachea should be opened below the fracture, and a long tracheotomy-tube introduced ; when the fracture is low down, the lower end should be hooked, raised, and sutured to the skin or upper fragment.

Spontaneous ruptures of the trachea, due to violent efforts, are accepted by some. All these fractures are more serious if accompanied by displacement which obstruct the air-passages.

The SYMPTOMS are those of obstruction and shock, plus those of fractures in general—crepitation, abnormal mobility, plus also aphonia, dysphagia, emphysema. The fragments should be replaced by external and internal manipulations ; if necessary the parts should be incised through and the fragments stitched. *Tracheotomy is often indicated :* it is well to perform the operation before grave symptoms develop, because these sometimes come on so suddenly that the patient may succumb before the surgeon can be had to operate.

Laryngo-tracheal abscess causes much dyspnœa, and shows a tendency to extend down along the trachea.

Such lesions are often the starting-points of the peculiar broad or diffuse cellulitis of Dupuytren ; they are sometimes secondary to cellulitis of the substernomastoid connective tissue ; they are at times produced by cold, by crying loud, so that the public criers and street-venders are most often affected ; usually it is women in bad health that are most commonly affected ; men very seldom. These diseases are usually connected with some general diathesis ; they may extend from the ear to the clavicle and from the nucha to the larynx ; they may involve also the other side. The pus is infiltrated in the muscular interstices and the connective tissue ; gangrene is not infrequent. The pressure symptoms are very great. This description resembles that of the disease called diffused cellulitis of Gray-Coley and Hannon, which they say is mostly limited to the anterior region of the neck—is due to cold and humidity, and resembles erysipelas : it gives the sensation of hard œdema without fluctuation. The inflammation of the infrahyoid region gives rise to greater risk of œdema of the glottis and extension to the mediastinum.

Bursal cysts develop in the serous bursæ found in front of the hyoid bone, Adam's apple, the cricoid cartilage ; they are usually called hygroma or hydrocele of the neck ; they form the group of the thyro-hyoid cysts. All the **tumors** of this region present these peculiar features : first, they give rise to more grave pressure symptoms than anywhere else ; second, they are usually in the way of tracheotomy, and relief can only be found by operating ; they often penetrate behind the sternum, and in order to follow them it is necessary to remove the upper part of the sternum. These retrosternal tumors should be explored with the syringe first ; when fluid they should be treated by incising and packing ; when solid they should be explored by an incision, and, when possible, enucleated. Great care should be taken not to excise any of the deeper parts of the walls, because the large veins of the region are often adherent to them, and are thus severed, when uncontrollable deadly hemorrhage supervenes ; the walls should not be incised even between the two forceps or ligatures, because if these large trunks are involved, the interruption to the circulation may be too serious. Most of these cases are operated for palliative purposes of a temporary nature.

In cases of injuries and inflammations about the neck the great dan-

ger is from suffocation due to the obstruction of the respiratory tract from swelling or œdema of the glottis, or from displacements in cases of fractures or ruptures. These accidents often come on so suddenly that the surgeon has not always time to reach the patient and operate in season to save the life; therefore precautionary anticipating tracheotomy should be performed at the least evidence of serious suffocation. It can be well done under cocaine; it will relieve the existing symptoms of dyspnœa, will prevent their aggravation or the death of the sufferer, and will not add to the risks if properly and regularly done. The tube should be long, because of the existing inflammation, and because the inflammation that will follow may lift the tube out of its proper position and render the procedure useless, deceptive, and dangerous—because it will lead to the belief that the operation has been done with no benefit.

When fractures or ruptures are strongly suspected, after the threatening suffocation has been removed by tracheotomy it is important to examine thoroughly and repeatedly with the *laryngoscope* to ascertain if there is any obstruction visible with the instrument; if none is seen, and yet a fracture is strongly suspected, the surgeon must explore directly—cut down to the hyoid bone, the thyroid cartilage, the cricoid, the trachea—and remedy all deviation causing obstruction, using catgut or silver stitches and small silver bands as splints or pins inserted through the fragments. It is of paramount importance that there should be no impediment when the tracheotomy-tube is removed; if all these efforts have not been made, the patient may have to wear a tracheotomy-tube for life or submit to the above manœuvres after the fractures or ruptures have united—*i. e.* under the greatest disadvantages.

In cases of growing aneurisms at the root of the neck, in view of the distressingly painful condition of these patients and of the fact that they are doomed, the surgeon is justified in *resecting the upper part of the sternum as an exploratory operation*. When it is found that the aneurism is one of the origin of the right subclavian, and that the innominate is not dilated beyond an inch and a half, it is advisable and justifiable to make the desperate attempt of tying them by applying two or three strong catgut or kangaroo ligatures, with as much of a bloodless space as possible between, and tighten them as much as deemed safe without rupturing the coats. The same remarks apply to the left carotid and subclavian if they are not dilated beyond an inch in diameter.

In cases of tumors of the infrahyoid region penetrating down behind the manubrium, the same resection for exploring purposes is recommended, with a view to total removal of the tumor if it is found possible.

THE THYROID BODY.

The location of a disease in the thyroid body is recognized by the fact that the organ ascends and descends with the larynx during deglutition. Another way to determine if the tumor is of the thyroid body is to seat the subject with the head stretched back and resting; then with the thumb communicate a slight but brisk movement from below upward: if the tumor budges, it is because it is not adherent or is little so.

Congenital Malformations.—*Absence of the thyroid body* has been observed occasionally in whole or in part, and *congenital atrophy* has been occasionally observed.

Congenital hypertrophy may affect the whole region or one side only, or even one part. There are also cases of aberrant thyroid, due

to the separate development of some of the lobules of the organ; these may be single, double, or multiple, or unilateral, as low down as the sternum or even behind the manubrium.

Acquired atrophic malformations are due to injuries, to diseases, and to surgical operations destroying or removing the body in part or in whole. The *total* destruction or removal of the thyroid gives rise to a peculiar train of symptoms. The immediate sequels of total destruction of the entire thyroid by thyroidectomy are acute mania, tetany, hysteria, myxœdema, or cachexia strumapriva. (*Vide* Vol. I. Chapter VIII.)

Few who have been operated before full growth escape; the signs begin to show on the third or fourth day; there are paleness, lassitude, weakness, anæmia; swelling and coldness of the extremities; muscular tremor; swelling of fingers first, then of the rest of the body, mostly apparent in the face and neck; this swelling is not œdema; it is hard and elastic, without pitting; the face presents the characteristics of this swelling in the highest degree; there are also cephalalgia, vertigo; the pulse is small. In tetany there sometimes exists such swelling, but it is not infectious. The complication is prevented by not removing the whole mass—*i. e.* by leaving a portion, especially that which is adherent to the trachea.

The best TREATMENT is by thyroid extract or the transplantation of the thyroid body of the sheep into connective tissue or the abdomen. The changes are relative to the alteration of the mucin and other metabolic waste. Pachydermic cachexia (or myxœdema of English writers) resembles myxœedma, and results from the destruction of the body by disease.

Wounds of the thyroid body are apt to be serious, on account of the great vascularity of the organ and its friability; the bleeding is usually great, especially if breathing be obstructed or laborious.

TREATMENT of hemorrhage is difficult, because of the friability which will not allow a ligature to hold tight enough to arrest the bleeding with safety against secondary hemorrhage. The same remarks apply to the forceps left *in situ*. Deep suturing succeeds best, or a chain ligature or a purse-string ligature; a pin or needle suture, such as is used for hare-lip, sometimes succeeds; pressure is not borne; it is useless to ligate the nearest trunk, because the other vessels will keep up the hemorrhage. When the bleeding is serious, tracheotomy, if practicable, sometimes stops the hemorrhage by relieving its congestion; in spite of all, death is sometimes the result of hemorrhage.

Congestion or *hyperæmia of the thyroid body* is frequent on account of its great vascularity—*i. e.* simple congestion independent of any forming or formed goitre.

The CAUSES are all internal; the physiological are—efforts of all kinds, menstruation, coition, pregnancy, accouchment; the most common pathological causes are—impediments to the venous circulation, the existence of infectious diseases, intermittent fever, endemic influences: repeated congestions cause goitre.

The TREATMENT consists in removing the cause and in the treatment of congestion in general. When suffocation occurs, save during pregnancy, the trachea should be opened.

Thyroiditis, sometimes called inflammatory goitre, acute goitre, strumitis, is usually unilateral. The *external* causes are the various traumatisms, infection of an ordinary wound, the influence of cold, etc. The *internal* causes are an effort causing a hæmatoma, the influence of rheumatism, a pre-existing infectious disease, especially pyæmia, puer-

peral fever, malaria. The pre-existence of a congestion or tendency to a goitre is a great predisposing cause; if it discloses itself in a manifest goitre, small or large, it is not a true thyroiditis, but a strumitis. *Suppurating thyroiditis* is always of a microbic origin. The pathological peculiarities are that death may take place before suppuration has been established: when formed, the pus may fuse in the mediastinum, along the respiratory tract, and the œsophagus.

The peculiar SYMPTOMS are great thirst, owing to difficulty in and aversion to drinking on account of the pain in swallowing; raising at each pulsation of the carotid arteries; cephalic symptoms, due to the pressure upon the veins; great congestion of face, and epistaxis due to the same causes; nausea and vomiting, due to pressure upon the pneumogastric.

The COURSE is continuous; the DURATION about fifteen or twenty days. The terminations are by persistent indurated spots or by suppuration; sometimes abscesses are formed; fistulous openings, single or double, occur; the abscesses may open into the larynx, trachea, œsophagus, or may fuse in the mediastinum; gangrene of the thyroid sometimes takes place.

The PROGNOSIS of thyroiditis is grave.

Tumors of the Thyroid Body.—Cystic tumors are represented especially by *hæmatoma* following an injury or due to a hemorrhage in a pre-existing cyst, either from a traumatism or from a puncture with a too large needle, and removal of all the liquid or enough to destroy the equilibrium of the pressure. Pulsation in the thyroidal tumors is not uncommon, owing to the pressure on the great vessels. *Congenital mixed cysts* are the most common; they contain thyroid vesicles, pavement epithelium, cartilage, muscular fibres. A peculiarity of the thyroid cysts is that, whether small or large, they may from sudden congestion or rupture cause suddenly great dyspnœa, which may be rapidly fatal. Cystic growths of the thyroid should be enucleated, as this avoids any possible injury to the recurrent laryngeal nerve, and also avoids the possibility of cachexia strumapriva by leaving all the thyroidal tissue that is not diseased.

Solid tumors are represented mostly and almost entirely by goitres: although they sometimes contain cavities or cysts, yet their walls are usually so thick they are considered as solid tumors, and are described with such. The great majority are simple hypertrophies.

GOITRE.

This is an enlargement or hypertrophy of the thyroid body without structural changes; it may involve the whole region or be unilateral or bilateral; it is more frequent on the right side.

The CAUSES of goitre in general are not yet known. The alterations as regards size and shape are variable. The microscopic alterations consist in cavities, channels, and compartments lined by a pavement or cylindrical epithelium. This form of goitre is the primordial form; it is epithelial or follicular: the other forms of goitre are only modifications of it.

The SYMPTOMS are those of a hypertrophied organ in general; the

peculiar symptoms are—the shape of a horseshoe; the movements following the larynx; the veins developed on the surface; the peculiar deformity of the region; the pressure-symptoms on the cerebral and facial circulations.

The COURSE is usually very slow, and sometimes irregular.

The DURATION is ordinarily very long.

The PROGNOSIS becomes serious with the degree of pressure-symptoms and the complications.

The true TREATMENT of goitre consists in extirpation, especially if it grows and if the pressure-symptoms are serious. We must bear in mind that an apparently innocent goitre may suddenly enlarge and cause suffocation or even sudden death.

The internal treatment consists in long-continued thyroid-feeding, which will diminish the size of a goitre and even bring on a condition of atrophy, so that the danger lies in abolishing the functions of the thyroid. Sodium phosphate has the same effect and consequences.

We should be careful in using anæsthesia if there are already signs of pressure; the use of morphine or cocaine is preferable.

Operation *with cocaine* is often possible; the pain does not seem to be beyond endurance; the dangers of the operation are much lessened without anæsthesia; there is much less turgescence of the veins than when an anæsthetic is used—none, of course, from coughing, vomiting —and the dangers of complications are thus diminished. The incision should extend from one side of the neck to the other in a very sharp and long curve, with the convexity downward toward the sternum. The upper part of the tumor would better be attacked first, and the upper vessels tied, then the middle or the inferior; the hemorrhage is reduced to a minimum by careful hæmostasis by means of forceps and double ligature of the larger vessels before incising between the ligatures.

When the inferior thyroid artery is being dissected and tied, by engaging the patient in a conversation for a few minutes the possibility of including the recurrent laryngeal nerve in the ligation is avoided, as the altered voice immediately warns the surgeon of the danger. At the lower right angle is the portion which often penetrates into the mediastinum behind the sternum; there exist usually at that point large veins. When possible lift the body from its bed and encircle the pedicle with an elastic tubing before enucleating, as recommended by Rose and Poppert. The dangers are hemorrhage and asphyxia by blood falling into the trachea when it is torn: to avoid these perform preventive tracheotomy when possible. In the hypertrophied thyroid the arteries are larger than in the normal, but are in their usual situations. Be careful again not to tear the trachea: if this happen, introduce at once a long tracheotomy cannula.

In exophthalmic goitre Kocher resorts to ligature and ties only three arteries. In one case when four arteries were ligated tetany set in immediately. Intracapsular enucleation is the safest, but is not always feasible. When the difficulty of tracheotomy is due to pressure, division of the isthmus may afford relief.

Aberrant goitres are those found in the supernumerary thyroid bodies—*i. e.* those in the lobules developed independently and which failed to unite with the rest of the body: they are sometimes called ganglionic goitres, because they resemble hypertrophied lymph-nodes. *Peri- and retrovascular goitres* are those which send processes around and behind the large vessels of the neck. *Colloid goitre* is one that attains the largest proportions.

Exophthalmic goitre, or Basedow's or Graves' disease, is accom-

panied by protrusion of the eyeball and tachycardia, with irregular, frequent loud sounds; the heart is dilated; there is also alteration of the normal sounds; the arteries of the wrist and head throb. These symptoms are due to changes in the middle and lower ganglions of the sympathetic. Suppuration is very rare. There is a *surgical exophthalmic goitre*, due to the pressure upon the nerves, purely mechanical and very distinct from Graves' disease. In *goitre with a feeble heart* and a weak pulse great care should be exercised in operating. Inflammation of a goitre is called **strumitis**: it is much more frequent than thyroiditis or inflammation of a normal thyroid; it is serious because of the enlarged condition of the organ. Tracheotomy may be performed for relief until the pus is located and evacuated by incisions or by dilatation upon a guide.

All the other solid tumors of the thyroid body are rare. **Sarcoma** is more frequent, and has been observed in all its varieties. The difference between hypertrophy and sarcoma is that usually the hypertrophy has the same shape as the gland, whereas the sarcoma has not. **Carcinoma** is also among the infrequent tumors of the thyroid outside of goitre. It is sometimes connected with the œsophagus or larynx; it may be metastatic from the cancer of some other part. The primitive cancer is the one here considered: it is rare, and is met especially in goitrous countries.

The Suprahyoid or Submental Region.

Incised wounds when transverse usually gape a great deal, but very little when longitudinal; usually the *suicide*, throwing his head back, cuts higher than he intends in the suprahyoid region, so that the borders of the stretched sterno-mastoid protect the vessels. The **penetrating** wounds open the cavity of the mouth, injure the tongue and epiglottis; there may be suffocation due to the blood or other foreign substances, or to the tongue or epiglottis falling back and occluding the larynx; there is usually much hemorrhage from the wounding of the lingual artery. More than in all injuries of the neck, we meet here with swelling and œdema of the aryteno-epiglottic folds, which are directly injured. The gaping is especially very great when the head is thrown back; the saliva and food pass out of it during deglutition. Wounds of the **epiglottis** cause much suffocation, difficulty of speech, of deglutition, coughing; thirst is a common symptom. **Lacerated wounds** are observed in several cases of *hooking of the chin*.

Congenital branchiogenic cysts of the region of the hyoid bone extend sometimes into the mouth and resemble ranula, but they are independent of the submaxillary and sublingual glands. Simple serous or **suprahyoid grenouillettes** have been studied only recently: they are usually seated underneath the cervical fascia; they are very often an extension of a sublingual cyst or grenouillette through the muscles of the floor of the mouth. *Dermoid cysts* sometimes remain dormant for a while, and then become apparent; if by the history the cyst may be traced to infancy, it is a dermoid cyst.

Foreign bodies in salivary passages are most frequent in Wharton's duct; they may be bristle, fish-bone, straw, hair of a tooth-brush. There

are pain, swelling of the gland, abscess, fistula. They may give rise to *salivary colic.*

The TREATMENT is that of all similar cases.

All the other tumors are rare and present no peculiarities.

Hyperæmia is represented here by the submaxillary mumps, seated in the salivary glands, very rarely existing independently, and usually associated with parotid mumps.

Inflammation under the form of *phlegmon* is very common in this region. It is usually due to lesions of the face, mouth, tonsils, and especially dental caries, with periodontitis.

Inflammation with abscess of the salivary gland itself is extremely rare. *Osteo-periostitis* from diseased teeth is often confounded with adeno-cellulitis; in the former the swelling corresponds to the body and to the border of the maxilla; its tendency is toward the face and the masseter portion of the cheek; the vestibule is painful and sometimes fluctuant. In adeno-cellulitis the swelling exists below the maxilla and has a tendency toward the neck. *Chassaignac's subangulo-maxillary adeno-cellulitis* is met with beneath the angle of the jaw, and is due to the difficult eruption of the wisdom tooth.

Ludwig's acquired or infectious submaxillary angina is characterized by excessive swelling and pain; the tongue is swollen and immovable; the mouth is distended in front; there is difficulty of swallowing; it may terminate in gangrene; it often ends in death.

The TREATMENT of these abscesses consists, of course, in evacuating the pus as soon as possible. Incision should be made under and parallel with the inferior border of the maxilla, so that the cicatrices will not show; by using the method of dilatation on a guide the evacuation takes place when the exploring needle has located the pus, and there is no cicatrix of any consequence remaining.

Retropharyngeal abscesses often point toward this region, although they may fuse down into the mediastinum; in the former case the large vessels are between the pus and the surgeon's knife. It is best to try and evacuate through the mouth, to avoid the course of the large vessels and nerves. An incision on the middle line of the pharynx, if it will accomplish the object, is preferable, as safer; it is well then to place the patient in Rose's position to prevent the entrance of the pus into the larynx.

Salivary calculi are peculiar to this region; they give rise to pain and swelling; sometimes abscesses are followed by fistulous openings, temporary or permanent. The calculi sometimes occupy the centre of gland or the deep surface, and the most important symptoms, as also the fistulous openings, are in the mouth. They are diagnosed by searching carefully for the opening of the fistula and probing it, when the peculiar click will be felt; if necessary, a needle thrust deeply through the gland in several directions will strike the calculus if it be present.

THE PAROTID REGION.

Congenital absence of the parotid and atrophy of the gland are very rare. However, occasionally subjects are seen with a deep hollow between the ramus of the jaw and the mastoid process, showing the partial atrophy at least of the gland.

Injuries of the parotid region are rare; they are grave, on account of cicatricial disfigurement and injuries to the facial nerve and to Stenson's duct. Incised deep wounds are most serious.

The DIAGNOSIS of the penetration of the gland rests upon the escape of saliva. When the wound is narrow, the hemorrhage, and later the suppuration, prevent the diagnosis; if the pus is very liquid, it is probable the gland is seriously injured. To prevent fistulæ, stitch tight and procure rest of jaw. *Deep wounds* are more serious, because of the presence of the temporo-maxillary vein, which becomes the external jugular; also of the other deep vessels.

The bleeding is profuse and sometimes terrific: it should be at once stopped by plugging; then a provisional loop ligature should be applied on the common carotid close to the bifurcation; the bleeding points should then be ligated. If this fails, it should be determined with care which vessels furnish the hemorrhage. If the external carotid, ligate it; if the internal carotid, ligate it separately, or ligate the common carotid at the very bifurcation to prevent the return through the collateral circulation; if the jugular vein is injured, ligate it as high up as possible, at least above the facial and lingual, or ligate these. After the ligation or ligations have been done, the accidental wound should be packed tightly.

Hyperæmia of the parotid is here represented by the disease called mumps. It is considered a specific infectious disease; it is contagious in schools; it is most serious in spring, in damp and cold weather; young male children are more commonly liable; sometimes it follows orchitis, but it is usually the reverse.

The PATHOLOGY is obscure.

The most remarkable SYMPTOMS are pain and swelling without redness or heat, softness of the part; no induration; no fluctuation; the pain is increased by biting, chewing, swallowing; there is little or no general reaction. The beginning is often sudden, also its termination; it sometimes moves suddenly to the testicles, ovaries, or breasts.

The DURATION is about ten days.

TERMINATION by resolution is the rule; it is altogether exceptional when it suppurates.

The TREATMENT consists of soothing liniments and keeping the parts warm.

Acute parotiditis is a comparatively rare disease. Its cause may be mumps (rare), a debilitated state of the system, an infectious disease (typhoid fever, sepsis); it may be complicated with ear, eye, tonsil or brain syphilis, but it is very rare. A pathological peculiarity is that the capsule of the gland prevents the pus from coming to the surface quickly.

The SYMPTOMS are those of deep cellulitis, with the addition of the general symptoms due to the lesion which is the cause of the parotiditis. It terminates almost always by suppuration; the pus may open in the ear, pharynx, vessels, down in the neck and chest, in the space behind the pharynx; it may terminate by several successive abscesses, it may terminate also by gangrene.

The PROGNOSIS is most grave.

The TREATMENT consists in keeping the mouth disinfected and in an early evacuation.

In superficial abscesses be mindful of the course of the facial nerve and of Stenson's duct; in deep suppurations, of the external carotid: in these cases follow Hilton's method or dilatation upon a guide.

Fistulæ of the parotid are not very common.

The PROGNOSIS is bad, because they are often difficult to cure.

The TREATMENT consists in local cauterization—if insufficient, in making a large hole in the region and closing the surface opening by a plastic operation ; in persistent cases, in destroying the parotid.

Tumors of the Parotid.—The lymphatic nodes, while not situated in the parotid, may present almost all the tumors that develop in the salivary gland ; they are called supraparotid tumors ; they are usually movable, whereas the tumors developed on the parotid gland are not.

Solid tumors of the parotid may be of all the varieties elsewhere found. **Chondroma** forms 30 per cent. of the tumors of the region. **Sarcoma,** together with fibroma and cystoma, is about equally often present. **Carcinoma** represents about 45 per cent. of all the tumors of the parotid region. Usually they are mixed tumors, in which the epithelial element has taken a great development ; they may be secondary to similar tumors originating in the pharynx or on the face. Primary carcinoma is rare. Encephaloid develops at forty-one, on the average. Pulsating encephaloids are very rare. Melanotic cancer is very rare ; it usually involves the lymphatics. Scirrhus usually develops at sixty or seventy. Mixed tumors are commonly those called simply chondromata ; they usually remain limited to the parotid, and do not invade the other regions ; they may become very large, so as to affect the mastication ; some have a rapid course, some a slow one ; they may degenerate into sarcomata ; they return rarely if operated in the first period ; they return often if operated in the second period ; generalization is very rare.

Tumors special to the parotid region are represented by the **salivary calculi** developed in the parotid ; they are rare in the gland itself ; they are said to be more frequent in males and in adults ; also to be due to the inflammation of the duct-radicles which retard the flow of the saliva ; also to changes in the chemical composition of the saliva. They usually cause pain, inflammation, and an abscess, which upon opening leaves a salivary fistula : using the probe through the opening or by penetrating the gland deeply with a needle, the calculus is felt ; they may cause atrophy of the gland by sclerosis. They should be removed through an incision.

OPERATIONS ON THE PAROTID REGION.

The possibility of extirpating the whole parotid has been much discussed, but it presents no practical or clinical value. When the gland is diseased, the disease must be removed, whether it affects the whole gland or not. A partial disease of the gland with prolongations is as bad as, if not worse than, a disease affecting the whole gland without such processes. The dissection should proceed from below and behind, upward and forward ; the external carotid should be located and ligated or clamped, otherwise it might be cut several times. When the dissection leads into the deep parts, the patient's mouth should be opened, as this increases the size of the parotid cavity and renders the deep dissection easier by affording more room. A previous permanent ligation of the external carotid might be done, or a provisional loop ligature applied to the bifurcation, so that if it should become necessary to ligate the internal carotid, the same incision will answer for all purposes. In penetrating the region the dangerous structures are at the entrance, and in front, to the inner side of the head and neck of the condyle ; more deeply, they are on the posterior wall. Some tumors of considerable size, and sometimes extending to the pharynx, are removed with little difficulty and little hemorrhage if the adhesions are loose ; whereas adherent tumors, even of

small size, are fraught with danger. The safe plan is to proceed as long as the adhesions with the surrounding structures are easily broken, and to stop as soon as they become too resistant and as we approach the deep dangerous structures, which may be adherent to the tumor. Then the cleared part of the tumor should be cut off. It is a remarkable fact that often the stump left will, in growing again, become more superficial, and it is sometimes possible to remove the stump entirely by a second operation.

The Lateral Region of the Neck.

Congenital malformations are represented in this region by the orifices of the branchial fistulæ situated most commonly along the lower part of the anterior border of the sterno-mastoid ; also by the congenital deformity of the sterno-mastoid, called hæmatoma of the sterno-mastoid and congenital torticollis ; also by the congenital atrophy of the same muscle. Acquired malformations comprise the various forms and varieties of torticollis and the deformities due to cicatrices. Cicatrices of the neck are most objectionable especially when affecting exposed parts.

Penetrating wounds of the external jugular, of the internal jugular, and the carotid arteries are most serious injuries. They may all give rise to circumscribed or diffused hæmatoma. When this is of some size and stationary, it must be aspirated or incised. When it pulsates and grows, it is because a traumatic aneurism has formed, and the wounded vessel, vein or artery, must be ligated above and below at the injured point. When the penetration is comparatively small the sac may be incised at once, after making as good pressure above and below as possible. When the puncture is large and there is risk of the patient bleeding much before the proper ligatures are secured, a provisional loop ligature must be applied below the wounded point. When the wound or the swelling is very low down, enough of the sternum must be resected to reach the root of the carotid and the innominate, and apply there the provisional loop ligature. Considering the gravity of a possible terrific hemorrhage, this advice is not too heroic.

Wounds of the vertebral artery in this part of the neck are more common in the canal of the transverse processes. At the base of the neck the wounds of the vertebral are more grave than those of the carotids.

The DIAGNOSIS of this wound will be made only when upon cutting down through the extravasated blood it is found that the carotid artery and the jugular vein are intact. Then, when the hemorrhage is profuse, it should be stopped by plugging with the finger or by packing, and a loop ligature should be applied on the subclavian or the innominate before proceeding farther ; when the wound in the vertebral can be located, it should be tied above and below ; if necessary, a transverse process should be cut away with the bone-nippers. These remarks apply also to the wounds of the *deep cervical*, the *inferior thyroid*, the *superior thyroid*, the *lingual*, and the *pharyngeal*.

Wounds dividing the sterno-mastoid muscle may entail power of the muscle from lengthening due to the cicatrization. When the muscle has been completely severed and the head is still, it is sometimes brusquely thrown to the severed side by the contraction of the

intact sterno-mastoid. In case of division of the muscle from operation this does not take place, because the other muscles have gradually become accustomed by the pressure of the tumor to keep the head properly balanced. The severed ends must be strongly and closely stitched with strong catgut, and the head kept in proper position by a liquid-glass bandage.

Incised penetrating wounds of the internal jugular are perhaps more serious than the wounds of the carotid, because of the danger of penetration of air. When the respiration becomes embarrassed the hemorrhage increases, just as in tracheotomy, where as soon as the tube is introduced the hemorrhage ceases. These wounds are oftenest tearing wounds during the removal of tumors.

Whatever be the cause, if the vein alone is wounded the blood is black and flows continuously. The first thing to do is to plug the opening to prevent the penetration of air; then make pressure above and below with the fingers, enlarge the wound, and fill it with boiled water to prevent the possible penetration of air; then look for the wounded vein and ligate both ends. The proximal end is the most dangerous, because of the entrance of air and of the abundance of blood. When the compressing fingers are in the way, or if their pressure is ineffectual, a provisional loop ligature should be placed around the internal jugular until the wounded ends are ligated. When the wound is low down, it may be necessary to resect the sternum and place a provisional ligature around the innominate vein or the superior cava. Incised wounds of the *superior thyroid, lingual,* and *facial* veins close to the internal jugular are almost as severe.

Incised penetrating wounds of the **carotids** give rise to profuse, even terrific, hemorrhage. When the wound is large or when the hemorrhage is moderate, unless at once attended to on the spot, it may be immediately mortal. A man will thus bleed to death in four minutes from the carotids, it is said. When the larynx or trachea is wounded, the blood penetrating in them causes death also from suffocation.

The hemorrhage is sometimes stopped by fainting if the wound is not too large. Upon reaching such a case, the first thing to do is to plug the wound with the fingers or pack it quickly. Packing will stop the hemorrhage only temporarily if the vessel is of any size above one-sixteenth of an inch. It is best and safest to enlarge the wound and attempt to ligate the two ends in the wound; if this causes too much bleeding, a loop ligature must be applied, as above described. If the bleeding has stopped, it must be borne in mind that it will almost surely return, and that it may do so when proper surgical assistance cannot be procured, and the patient may bleed to death; therefore, the case should be treated as described above for punctured wounds.

Incised wounds of the nerves of the region (recurrent, phrenic, pneumogastric, sympathetic, spinal accessory, cervical plexus) are followed by the following symptoms: When the recurrent is wounded there is aphasia more or less complete. The section of the phrenic and pneumogastric on one side only is accompanied by respiratory and circulatory irregularities; they are not necessarily fatal, but it is a most serious complication.

Park has shown that only about 50 per cent. of these cases are fatal. Complete wounds of the sympathetic are followed by atresia of the pupil, slight ptosis, congestion of the conjunctiva, headache, congestion of the side of the face (unless only stimulated); it produces mydriasis, pallor of the face, protrusion of eyeball. Injury of the superior laryngeal nerve is sometimes very serious. When possible the divided ends must be sutured with fine silk.

Rupture of the sterno-mastoid is the most common rupture of all

the muscles ruptured ; it has taken place after falls, sudden twists, violent muscular contractions. There are great pains, a depression on the course of the muscle, great hæmatoma ; the head is often twisted by the action of the other muscles.

The TREATMENT consists in placing the head in proper position and immobilizing it in a liquid-glass bandage. The rupture is usually partial ; when complete the ends are far apart ; it is well to cut down and stitch ; otherwise a kind of torticollis may result from the lengthening of the muscle.

Hæmatoma of the sterno-mastoid in the new-born is most remarkable and unique : it usually appears after birth ; it is more frequently on the right ; it occupies the body of the sterno-mastoid, partially or totally, forming a part of its substance ; it is firm, elastic ; it is oval ; it is stationary. There is no pain except on pressure ; the head is inclined as in torticollis ; there is no tendency to grow nor to suppurate ; it usually disappears by resolution in a few weeks or months. It is thought to be due to obstetrical traumatism or to a malformation ; it is common after breech presentation when traction has been made to extract the head ; it may cause a permanent torticollis. It must not be confounded with enlarged nodes.

Induration of the sterno-mastoid in adults is syphilitic : it may be a diffused sclero-myositis ; it may occupy the whole muscle, which is transformed into a cord, or it may be localized in one spot.

Gummata of the sterno-mastoid are found usually at the inferior insertion of the muscle ; they may attain the size of an orange. This muscle is a point of election of gummata ; they develop rapidly in four weeks, without traumatism and without trace of pain. One case of hereditary syphilis of the sterno-mastoid is reported.

Neuroses are represented by the disease known as torticollis.

Torticollis, also called **wry-neck,** is a deformity of the head and neck in which the face is turned upward and to one side. It is not a very rare disease. The causes are numerous. The pathological lesions vary also with the causes. There are also atrophy of the face and cranium of the affected side, sometimes strabismus, impairment of vision, dysphagia. There are usually no general symptoms.

Acute, transient, or rheumatic torticollis is that due to cold : it presents no cranio-facial deformity ; it may affect the sterno-mastoid, the trapezius, or all the muscles of one side.

The peculiar point in the TREATMENT is to immobilize the head in a soluble-glass bandage for a few days.

Intermittent or spasmodic torticollis is characterized by a sort of convulsive to-and-fro motion of the head without cessation for short intervals or during sleep. The name is a bad one, because there is no spasm, but simply a loss of dynamic action—a lack of muscular synergy. The head is easily restored to its proper position, but it returns to the vicious one : this may become permanent. The spasms are limited to the sterno-mastoid, trapezius, and splenius ; when the patient is lying down with the head flat there is no deviation ; when sitting up, the head loses its equilibrium ; it is first inclined laterally, and then in rotation ; the movements are slow, gradual, without jerks. The head is easily straightened by an assistant, but it falls back immediately when the support is withdrawn. Electricity and massage are the most usual means employed, together with a collar apparatus ; stretching or section of the spinal nerve has been done in one case with only temporary improvement.

In articular or osseous torticollis due to tuberculous osteo-arthritis, suboccipital

disease, cervical arthritis, and in that due to tumors, the head cannot be budged, from its absolute immobility on the vertebral column; the head is not twisted as in real torticollis.

In torticollis by contraction the head can be straightened; the muscle retains its shape and its contractility : it is the trapezius that is most commonly affected.

In torticollis by retraction the head cannot be thoroughly straightened, and there is the persistence of a hard-stretched muscular cord. Sometimes it requires the administration of an anæsthetic to determine these points, and whether it is the sterno-mastoid or the trapezius which is affected or the deep muscles.

Torticollis by retraction of the sterno-mastoid is also called torticollis by contraction. It is the most common : it is characterized also by a hard-stretched cord along the course of the sterno-mastoid, especially when the head is rotated in a proper manner. That it may be congenital is recognized, but it is rare; it is sometimes called obstetrical when it is thought to be due to the traumatism produced by the forceps; it may be due to myositis syphilitica or to a gumma; it may be due to disease of the central nervous system or to the nerves of the muscle. It is called ocular when induced by defects of vision—*i. e.* headache, diplopia, astygmatism, amblyopia.

The *pathological lesions* are a fibrous degeneration or transformation of the muscle : it usually occupies the lower two-thirds; the right side is more frequently affected. Cranio-facial atrophy is due to the defective nutrition of the parts.

The PROGNOSIS is that the deformity always tends to increase.

The TREATMENT consists in performing tenotomy, subcutaneously or openly, of the affected head or heads. The best time to *operate* is not before the third or fourth year. The disease has no influence on the development of the skeleton up to that age; after the tenotomy a proper collar apparatus, with or without suspension, must be used.

In *permanent paralytic torticollis* the head is inclined to the opposite side of the hemiplegia, due to the action of the sterno-mastoid of the opposite side : it may in the course of time bring on a retraction of that muscle. No other form of paralytic torticollis is recognized by most writers. The head can be straightened, and remains so only as long as it is supported.

The TREATMENT presents nothing special except to apply also a supporting apparatus.

Torticollis of the platysma has been observed, also of the scaleni. Hysterical torticollis is diagnosed by anæsthesia.

Inflammations in the sheath of the sterno-mastoid are common : sometimes they begin in one of the small lymph-nodes situated in the sheath itself; when originating from these, it is remarkable that the inflammation and the pus that usually follows it remain very strictly limited to the sheath, and descend toward the lower third of it, near the clavicular attachment, where they become superficial. This inflammation leaves after it a stiffness and a shortening of the muscle.

Phlebitis of the internal jugular vein is not very common; it is usually due to infections from the interior cavities or to metastasis. It is accompanied with great pain and swelling along the course of the vein; it is often complicated with phlebitis of the lateral sinus and with cerebral symptoms.

It is DIAGNOSED with the exploring needle; it is of the utmost importance to diagnose early and to evacuate early by incision or dilatation on a guide.

Angeioma of the neck is sometimes called *sanguineous cyst.* It must not be confounded with a cyst in which hemorrhages have taken place or have opened into a cavity; it may be superficial, deep, or cavern-

ous. Angeioma sometimes presents a single vein opening in the jugular by one or several orifices; sometimes several angeiomata open into the jugular. The neck is a special seat of ampullar venous dilatations, forming cavities in an erectile tissue with narrow spaces. Angeioma is often completely reducible. In operating it is advisable to place a ligation on the large vessels as soon as possible before extirpating the tumor, thereby diminishing very much the hemorrhage during the removal and facilitating the same. A sanguineous cyst is sometimes due to a serous cyst with a hemorrhage in its cavity.

The **aneurisms of the carotids** are seldom traumatic; however, they may be the result of contusions. The common carotid is more frequently affected; it is comparatively frequent in females, surely more so than the other aneurisms; it is also more common in young subjects than aneurisms of other arteries. These aneurisms may be confounded with vascular or aneurismal goitres, pulsatile sanguineous cysts of the thyroid when they exist on the course of the carotids; also with pulsatile encephaloids; also with other tumors of the neck situated on the course of the carotids.

The DETERMINATION of the affected artery in cervical aneurisms is often most difficult. Clinically and practically, the diagnosis is made by operating. A provisional ligature should be applied below the tumor. When this stops the pulsations, another ligature should be placed above: if this be not possible, the ligature below should be tightened, the sac incised, the upper end of the artery secured, and the bleeding points, if any, clamped, and the sac extirpated if not too closely adherent to the important vessels and nerves. When, after placing the loop ligature, the pulsations are not affected, it is because the wrong artery is attacked; the loop should still be kept in place and the vertebral should have a loop ligature placed under it, when the pulsations will stop; another ligature should be placed above, if possible.

The Supraclavicular Region.

Congenital Atrophic Malformations.—A form of atrophy of the region is presented in subjects, young and old, in whom the supraclavicular fossa is unusually deep, causing the deformity called "salt-cellar neck." Orifices of congenital branchial fistulæ are sometimes met with in this region.

Punctured wounds of the subclavian vein and artery may also give rise to serious hæmatomata. When persistent they should be aspirated or incised. We should bear in mind that hæmatoma may be due to a wound of the vein, and that the connection may still exist. This will surely be the case if after aspiration it fills up again. In case of incision the deeper clots should not be disturbed, so as not to open the wound in the vein in case that lesion has occurred.

Injury to the subclavian artery is recognized by the pulsations of the hæmatoma; it is then a traumatic aneurism. The artery should be ligated. When the swelling is moderate, the ligation should be made in the supraclavicular region, using, if necessary, an aneurismal needle with a detachable point. In the majority of cases this simple ligation will suffice to cure the aneurism; if not, compression of the axillary or its ligation should also be done; then the sac incised and the injured points ligated above and below.

When on the right side, the artery can only be reached and encircled in its second portion after dividing the anterior scalene; no permanent ligature should be applied there; a provisional loop ligature should be placed, the sac incised, and the injured point of the third portion ligated permanently above and below. On the left side the ligation of the second portion can be made permanent at once, as it is as safe on this side as a permanent ligature is unsafe on the second portion of the right side. When the swelling is so great as to cause the failure of the above procedure, or so as to discourage even the attempt, but only then, a provisional ligature should be applied upon the first portion of the subclavian; the axillary should be compressed or treated in the same way: then the sac is incised and the two ends ligated. In some cases these ends cannot be found. Packing with bits of aseptic sponge should then be resorted to, with compression over it. Should the hemorrhage return, the clavicle should be sawn through and the two ends secured.

Incised wounds of the subclavian vein are most serious, because of the amount of bleeding often causing rapid death, and also because of the quick penetration of air into the vein. The vein should be at once plugged with the finger, or, better, an aseptic packing; then an attempt should be made to enlarge the wound and to clamp it, and then ligate the two ends. When this is impossible a provisional loop ligature should be applied on the first portion of the vein; also compression should be made on the axilla and the two ends ligated; the ligation of the proximal end is to secure against hemorrhage and also entrance of air, but the ligature also of the distal end is of course indispensable.

Wounds of the lymphatic duct on the right side and of the thoracic duct on the left are diagnosed by the oozing of the peculiar fluid they contain. If possible, the distal end should be ligated, and this usually stops the flow, since there is a valve on the provisional end. There is seldom if ever any discharge from it. When ligation is impossible, compression will often suffice. It is very seldom that any further trouble is noticed, because there exists usually two or three branches of that duct, and the uninjured ones carry on the circulation. When this fails and a chyle fistula is established, then the patient gradually loses flesh and succumbs.

Wounds of the brachial plexus are followed by paralysis of the affected area; they should be sutured at once. The lesions, from whatever cause, may affect only one branch. These neuroses never affect the internal, anterior, and posterior surfaces of the arm, because these are supplied by the anastomoses of the intercostal filaments with the internal cutaneous. They must not be confounded with the anæsthesia and paralysis resulting from contusions of the shoulder in hysterical subjects (hystero-traumatism).

The TREATMENT is by electricity. If a callus includes a nerve, it must be resected.

Incised *wounds of the phrenic nerve* are most serious. However, when the nerve has been pressed upon by a tumor for some time, the wounding of it is not so dangerous.

Incised wounds of the **apex of the lungs** are not so apt to be followed by emphysema as the punctured wounds.

Neuroses.—Sometimes the callus of a fracture of the clavicle includes a nerve branch; hence neuralgia or paralysis requiring resection of the callus. A simple contusion, without fracture, may produce a paralysis of the plexus. Repeated slight contusions may produce paralysis, as in the case of the strap of the carriers, especially water-carriers.

The Posterior Region of the Neck.

Wounds of the spinal canal through the interlaminar spaces when the head is flexed forcibly, or through a fracture of the laminæ, are serious only if becoming infected.

Incised wounds reaching the spinal cord itself are followed by paralysis of the parts below. If the wound be and remain uninfected, the cicatrization by primary union may take place and the paralysis disappear; if not, it will be permanent. If between the occipital and the atlas or axis the oblong medulla is severed, death is instantaneous. Infanticide is often produced by a long needle or pin driven between the occiput and the vertebra. If the lesion is above the origin of the phrenic, death follows quickly by paralysis of the diaphragm.

Wounds of the posterior region are said to be followed by sexual impotency when the membranes of the cord are involved; also by paresis and wasting of the lower extremities, also of the testicle. Larrey contends that this may take place even when the cord is not affected.

Ruptures of the muscles of the nucha are reported in those who carry heavy loads on the head.

The SYMPTOMS are those of other muscular ruptures.

Ruptures of the attachments of the rhomboid and of the elevator of the angle of the scapula have been seen in farm-laborers.

Neuroses are represented by acute **torticollis (posterior) of the trapezius.** This is said to be even more frequent than the torticollis of the sterno-mastoid. When in the trapezius and complexus, the head is inclined on the affected side, but the chin is toward the opposite side; the head is slightly thrown backward. There is no cord, no diffuse induration, no atrophy of the face : the pain is near the atlas, and is increased by pressure. Under anæsthesia the head can be straightened. This torticollis may be confounded with occipital arthritis with inclination of the head.

The TREATMENT consists in applying a soluble-glass bandage or a plaster apparatus; it should be worn one year.

When both the trapezius muscles are affected the head is thrown back. In cases of torticollis of the trapezius the sterno-mastoid is often also contracted, but it is a contraction of immobilization; the pain is along the trapezius, and not along the sterno-mastoid. Very often the torticollis affects also simultaneously the deeper muscles, the splenius, the elevator muscles of the scapula, the rhomboid. The scalenes and the platysma are sometimes the site of torticollis.

Aneurisms of the vertebral artery are not rare in this region ; they are usually traumatic, and are often high up. The artery should be ligated above and below if possible, or above or below whenever possible, and the sac incised and immediately plugged with aseptic sponges. If possible, the distal bleeding end should be ligated. In case a secondary hemorrhage should occur through the distal end, and be uncontrollable by plugging, the ligation of the vertebral on the other side must be considered and weighed.

CHAPTER VI.

SURGERY OF THE CHEST.

By Frederic S. Dennis, M. D.

MALFORMATIONS.

A congenital malformation of the thorax frequently occurs. This may follow a difficult parturition. The accompanying figure shows a congenital malformation in which the upper ribs were separated from the lower ribs and the lung protruded in the interspace. This condition remained as a permanent malformation.

There was a distinct sulcus into which the side of the hand could be thrust. Subsequently marked contraction took place, and the side of the thorax became permanently distorted.

Malformations of the chest may also occur as a result of the non-closure of the foramen ovale. The left side of the chest bulges outward and forward, and the hypertrophied right auricle is situated at a point far distant from its normal place. The apex-beat is situated below the margin of the cartilages of the eighth, ninth, and tenth ribs. The opposite side of the chest is compressed, so that there is a marked difference in the symmetry of the thorax.

Congenital malformation of chest
(Sayre).

Malformations of the chest may arise in consequence of a chronic pneumonia. Respiration in these cases is carried on with great difficulty; the pulse is rapid; cyanosis of the face is present; a dry cough harasses the patient; the alæ nasi are dilated; and the ribs have a limited movement, and are forced inward instead of outward by the act of inspiration. This peculiar respiration causes the transverse diameter of the chest to become diminished instead of increased.

Malformations of the chest occur as a result of *rickets*. The chief distinguishing feature is an alteration in the shape of the *thorax*, since there is usually a marked antero-posterior curvature, and the thorax is narrowed and flattened from before backward. These changes begin in early infancy or about the sixth to the eighth month, and may continue

until the third year or even beyond that time. The epiphyses of the ribs and cartilages become beaded and enlarged notably upon the pleural surface. To this condition the term *rickety rosary* has been given. This condition is the result of the effects of atmospheric pressure during the inspiratory act, combined with the lateral pressure induced by the weight of the upper extremities, and partly also by the fact that the ribs have lost their normal power of resistance. The angles of the ribs are less obtuse than in the normal chest, and the ribs are also somewhat shorter than usual.

Fig. 112.

Deformity of the thorax, the result of rickets (Gibney).

The *sternum* in the rachitic condition of the thorax may project forward or in rare instances may be depressed. The forward projection causes lateral compression of the cavity. The spine is subject to certain alterations in its normal curves, since the great dorsal curve is exaggerated, giving rise to the condition of kyphosis. This deviation is eventually compensated for by a corresponding exaggeration of the cervical curve and a marked diminution in the lumbar convexity. As the child grows, lateral curvature may also be caused, with the concavity to the right side, owing to the position which the child assumes while carried on the nurse's left arm. As the child grows up *scoliosis* is likely to follow in consequence of the vertical position which the patient assumes, together with the loss of resistance on account of the softened bones and ligaments.

Rachitic kyphosis must not be mistaken for Pott's disease. In the former case extension of the body while the child is in the recumbent position obliterates in a large measure the characteristic curve, whereas in tuberculosis of the vertebræ the extension does not affect the angular curvature.

In rachitic deformity the kyphosis is in the form of a curve, and not an angle, as in Pott's disease.

In the relief of kyphosis of the spine due to rickets some form of spinal brace can be employed when the child is up and about. In conjunction with rest in the recumbent position, good nutritious food, sea-bathing, and out-of-door exercise are to be employed as adjuvants, together with the use of the syrup of the iodide of iron and cod-liver oil.

Deformity of the chest also occurs in consequence of lateral curvature independent of any disease.

Malformations of the chest occur as a result of *empyema*. Under

these conditions the thorax may be *barrel-shaped*, and move up and down during respiration as if the cavity were formed of a single cylinder. The lateral expansion may be absent, and occasionally a marked bulging may occur in unilateral empyema.

In other cases there may be a marked sinking of the side of the chest-wall so that the thorax remains permanently deformed. Goodwillie mentions a case in which the ribs upon one side were lying upon the inner side of the ilium, and on the other upon the outer side. The deformity followed pleuro-pneumonia in youth.

Malformations of the chest may occur as a result of *traumatism* sustained in early life. The injury is independent of a fracture, and as

Fig. 113.   Fig. 114.
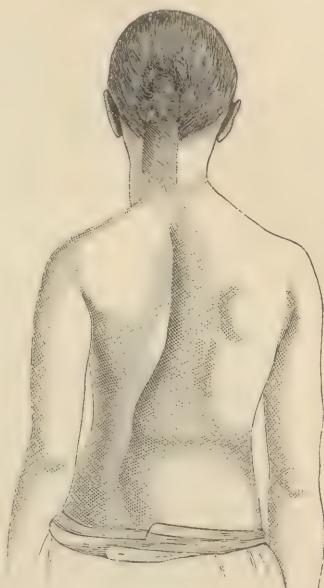
Malformation of chest following empyema (Sayre).

the child grows the distortion becomes well marked. Pott's disease usually results from this traumatism in a patient with tuberculous tendencies.

Malformation of the chest may occur in the form of *lateral curvature due to empyema*. The accompanying figures (113, 114), kindly furnished by Dr. Sayre, give a typical illustration of lateral curvature. The apex-beat of the heart is at the junction of the sixth costal cartilage and sternum. The distance from the umbilicus to the left nipple is twelve and a half inches, and from the same point to the right nipple fifteen inches. The left side of the chest-wall is depressed, and the right side bulges with rotation of the vertebræ: the latter circumstance is noteworthy, being contrary to the teachings of the German authorities.

Malformations of the chest also occur as a result of *pleurisy*. The pleura becomes adherent to the internal surface of the chest-wall, and in consequence the affected side is altered in shape and gives signs of arrest of development. The

intercostal spaces are obliterated, while those of the opposite side become exaggerated. The spinal column also is affected, as distinct lateral curvature follows.

The form of the thorax is also altered in consequence of a paralysis of the serratus, rhomboideus, and latissimus dorsi muscles. The angle of the scapula projects from the latero-dorsal aspect of the chest like a wing.

Malformation of the breast occurs to which the term *carus pectinatum* has been assigned. The deformity is difficult to overcome, but the treatment is considered in the chapter on Orthopædic Surgery.

Another deformity of the thorax is sometimes observed in a deep depression at the lower extremity of the sternum. The term *bird's-nest deformity* has been applied to this malformation, on account of a fancied resemblance. There is no treatment which will effect a cure.

We may have another deformity of the chest in consequence of *poliomyelitis*.

Malformation of the chest may occur as a result of long-continued

Fig. 115.　　　　　　　　　　Fig. 116.
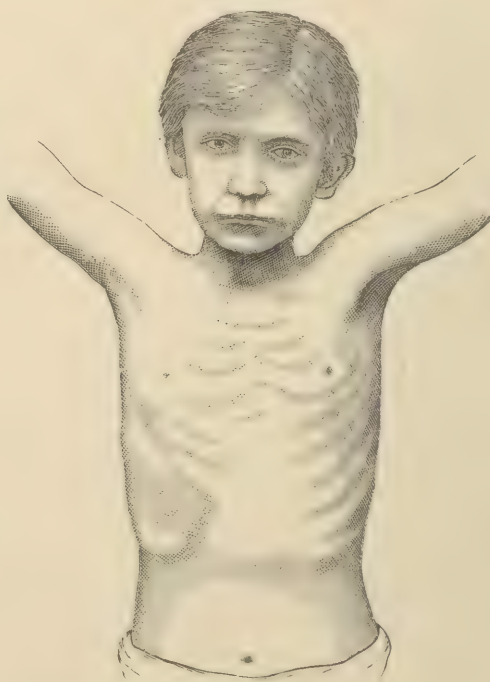
Malformation of the chest due to tight lacing (Goodwillie).

and *tight lacing.* The chest shows marked thoracic with slight abdominal respiration. The diaphragm has been arrested in its growth and the respirations are peculiar in character (Fig. 115).

Malformations of the chest may arise in consequence of certain *occupations,* also as a result of certain forms of *exercise.*

The bicycle-rider comes to have a peculiar chest when the exercise is long continued in the stooping posture. The writer has seen a well-pronounced deformity of the chest in which the patient presented apparent atrophy of the muscles of the left side of the thorax and marked hypertrophy of the right side. For many years the patient has constantly exercised the right side of the chest in the practice of his profession as a musical conductor. The muscles upon the right side were so largely developed that the condition gave rise to the appearance of a lipoma. The scapular muscles bulged out on the right side in consequence of the unremitting and long-continued exercise of the arm in the constant swing of the baton.

Deformity of the chest may follow in consequence of *spastic paralysis*. The chest loses its normal shape, and other muscles besides those of the thorax are involved.

Fig. 117.

Congenital absence of the pectoralis major muscle of right side (Richardson).

Malformation of the chest has been observed where *an arrest of development* in the vertebræ has occurred, and the sternum was either entirely absent or else imperfectly developed. The bone sometimes possesses a cleft in the centre. The ribs have been observed free or else attached to the sternum by fibrous tissue. The ribs have also been noticed as attached to each other in a manner similar to the lateral union

of two ribs after the opening in the chest and the introduction of a drainage-tube for the relief of empyema. In these cases of congenital defect some protection should be worn in the form of a shield, in order to protect the important thoracic organs from injury likely to occur on account of their great exposure.

Tattooing of the chest is of frequent occurrence. It is shown by Ellis that there is no class of people among whom tattooing is as common as among criminals. Alborghetti reports that the proportion is 15 per cent., and Lombroso 32 per cent., among prison inmates. Tattooing is almost exclusively confined to the male sex. In addition to the criminal classes, the insane often indulge in this habit. Children are seldom found tattooed. Lacassagne has shown that among the non-criminal classes only about 1 per cent. of the cases of tattooing are found. Among sailors the thorax is a favorite seat for tattooing, and the ship under full sail is most frequently the emblem. Lombroso tells us that tattooing upon the back of the thorax or upon the sexual organs is found only among the residents of the Pacific islands, except in cases where this has been done during prison-life. Lacassagne regards tattooing "as the uninterrupted and successive transformation of an instinct."

Malformation of the chest, finally, has occurred in consequence of a congenital absence of the pectoralis major muscle (Fig. 117). Stintzing has collected from surgical literature thirteen cases of this nature.

INJURIES.

Injuries of the thorax not proceeding from fractures are not serious, since in 225 cases of injuries of the chest due to kicks of horses, railroad disasters, falls, and other accidents, there were only 5 fatal cases, as recorded in the Surgeon General's reports of the late Civil War.

The **injuries** of the thorax, excluding fractures, which are considered elsewhere, consist of *contusions* and *wounds* of every variety. Inflammatory affections may also result from injuries, the peculiar features of which will be discussed later in this chapter.

Contusions of the chest-wall are caused by direct violence, as a blow or a fall upon the chest. If the injury is not associated with a fracture or a dislocation, a rupture of a large vessel, or visceral lesions, the traumatism is not serious. The seat of the injury shows the presence of ecchymosis and the existence of swelling. The patient experiences pain, the amount of which is largely influenced by the peculiar character of the trauma. The swelling is due to a hæmatoma, which quickly appears, especially if the attachment of the pectoral muscle is torn from its insertion.

In addition to the ordinary contusion of the chest-wall, an injury has been described under the name of *commotio thoracica,* which resembles contusion or laceration of brain. Sudden death may follow severe commotio thoracica and the autopsy fail to reveal any tangible lesion. In these cases the sudden death is due to shock. In commotio thoracica the pain is very severe, abdominal respiration is present, and a peculiar decubitus is observed, in which the patient, while lying upon the back, inclines at the same time toward the injured side. The fact must not be lost sight of that in apparently slight contusions of the chest-wall serious visceral lesions may occur. The pleura may be injured, the lung crushed, the pul-

monary air-vessels ruptured, and interstitial cervical emphysema follow. The pericardium and its contents may also be injured. In addition, secondary inflammatory complications may ensue.

The TREATMENT of contusions of the chest-wall consists in the administration of opium, provided there be no contraindication to its use. This drug relieves the pain, has a controlling influence over inflammation, and diminishes the number of respirations. Hot fomentations are often applied with benefit during the first few days, after which a broad strip of adhesive plaster is placed around the thorax after the manner of dressing a fracture of the rib.

In commotio thoracica the cardiac stimulents are indicated, such as strychnia, digitalis, strophanthus, and nitro-glycerin, as well as alcohol in the form of hypodermic injections.

In case dyspnœa is serious, artificial respiration should be employed, and if profound cyanosis is present, the inhalation of oxygen is indicated. The head should be lowered and artificial warmth applied to the surface of the body.

The management of contusions of the thoracic viscera in connection with external injuries of the chest-wall requires no special treatment aside from that to be presently considered under Wounds of the Viscera.

Wounds of the chest may be the result of a *gunshot* injury or a *stab*, either of which may be penetrating or non-penetrating. If the wound is non-penetrating, it is not usually serious; but occasionally a hemorrhage may occur from one of the large vessels upon the thorax, or the muscles be cut across so as to cause a hæmatoma and gaping in the wound. In consequence, a large hæmatoma develops under the skin, and the clot, if infected, may give rise to dangerous cellulitis.

If the wound is small, the parts should be made aseptic after first rendering the region surgically clean. Iodoform or aristol should then be sprinkled over the wound in a very thin film, and a thin layer of borated cotton should be placed over the powder, and finally the cotton film painted over with a little styptic collodion. Hermetically sealing the wound, as suggested by Howard, keeps it aseptic, and with the chest-wall made as quiet as possible by restraining its movements with a dressing similar to that employed in fracture of the ribs, the wound quickly heals. If an hæmatoma exists, it would be better to incise and turn out the clot and ligature any bleeding vessels, and disinfect and drain the cavity. If primary union fails, an abscess is likely to develop. This process may also ensue in consequence of a contusion or a tearing off of the attachment of the pectoral muscle, or from caries of the bones forming the chest-wall. In these abscesses fluctuation is not always felt, on account of the extravasation of pus by gravity.

The TREATMENT of abscesses resulting either from failure to obtain primary union in a wound or in consequence of injury or disease consists of early incision, disinfection, and the application of antiseptic dressings. If the bone is the cause of the suppuration or abscess, it must be thoroughly scraped or removed. The principle of fixation and rest should be employed in the same manner as indicated in the injuries of the chest-wall. The possibility of septic visceral infection from external abscesses must not be overlooked.

In the **non-penetrating injuries** of the chest-wall phlegmonous inflammation may occasionally occur. The phlegmon takes its origin in the loose connective tissue which abounds in the muscles over the scapula and beneath the pectorals and in the axillary region. The progress of the inflammation is very

rapid, and produces great prostration from septic intoxication. The anatomical arrangement of the axilla with its various compartments produces a honeycomb condition, so that the pus is contained in many small cavities.

The TREATMENT of phlegmonous inflammation in this region requires prompt action on the part of the surgeon and demands the most rigid antiseptic precautions. The numerous pockets must be opened, the contents allowed to escape, and the cavities thoroughly curetted and drained. Care must be exercised lest the important vessels in the axilla be injured and give rise to alarming secondary hemorrhage.

Before dismissing the topic of wounds of the chest-wall the non-penetrating gunshot wound should be considered.

Gunshot wounds of the thorax form about 50 per cent. of those which terminate fatally in battles, and about 10 per cent. of the gunshot wounds treated in hospitals. In the non-penetrating injury a fracture of the rib may occur or a wound of an important vessel or nerve. The non-penetrating wound, uncomplicated by any injury of the bones or vessels, gives rise to no special disturbance beyond that of any wound of the chest-wall, and the mortality is only about 1 per cent. The respiratory movements of the thoracic parietes often retard the healing process, and occasionally it becomes necessary to restrain the chest movements by broad strips of rubber plaster after the manner of treating a fracture of the ribs. In the old bullets the ball often took a circuitous course around the chest. The writer once removed a bullet from the angle of the scapula that entered the body in front near the edge of the sternum. In the modern rifle or pistol bullet this deflection is never observed. The chest-wall may receive a contusion from a shell, in which dyspnœa, pain, and collapse are present, at least as a temporary condition. In addition to the injury of the chest-wall the lung may receive a contusion or be compressed so as to give rise to severe symptoms of shock. Still further fractures of the bones forming the thoracic parietes, including the vertebræ, may increase the gravity of the case.

In these complicated wounds the PROGNOSIS is nearly always fatal. The pleura may also be torn or lacerated, and this also adds to the serious character of the injury.

If the axillary or scapular vessels are wounded, the danger of a fatal hemorrhage is immediate.

The TREATMENT of *non-penetrating* gunshot wounds of the chest involves the disinfection of the wounds, the arrest of hemorrhage from any external vessels by the application of a ligature at the distal and proximal ends, and, finally, the immobilization of the chest-wall. If hæmothorax occur, aspiration of the pleura is indicated. If the movements of the chest are painful, opium can be given, since its action is to diminish the number of the respirations and thus relieve the pain. The drug also seems to have a controlling influence over inflammatory sequelæ.

Pleurisy and pneumonia are treated along the lines usually laid down in connection with these diseases independent of any injury. The absence of microbic infection makes the prognosis more favorable than a pneumonia caused by the presence of pneumococci.

Penetrating gunshot wounds of the thorax are more serious. If the bullet be fired from the modern rifle or pistol, it is likely to perforate the chest-cavity. If the bullet injures a large vessel, the hemorrhage is

very profuse, and the patient dies very soon in consequence of the loss of blood. If a patient is not killed from hemorrhage at once in a gunshot wound of the chest, the prospects are favorable. In other words, if the patient survives the shock a few hours, he is likely to recover, since no large vessel is wounded and only the secondary effects of injury to the viscera may be expected.

The statistics of gunshot wounds of the chest have hitherto shown a very large mortality. This is due to the influence of sepsis, which in modern surgery is overcome. Thus in the Crimea the death-rate was between 80 and 90 per cent.; in the Franco-German War, about 68 per cent.; and in the Civil War, about 65 per cent. These figures are of interest only since the introduction of antiseptic wound-treatment has given brilliant results in perforating gunshot wounds of the chest-cavity.

The SIGNS AND SYMPTOMS of a perforating wound of the chest are severe pain, violent paroxysms of coughing, and expectoration of blood. If the pleural sac be filled with blood, there are the additional physical signs of compression of the lung, with diminution of the respiratory movements and dulness over the pleural cavity. If, instead of blood in the pleural cavity, air gains admittance, the resonance is tympanitic and the physical signs of pneumothorax are present. A perforating wound of the chest is often associated with other injuries, notably wounds of the important vessels, lodgement of foreign bodies in the chest, hæmothorax, pneumothorax, pyothorax, injury of the spinal cord and diaphragm, and even an associated abdominal injury. Hemorrhage may proceed from the intercostals, the mammary or axillary vessels, or from the large vessels situated in the thoracic cavity.

The TREATMENT of penetrating or perforating gunshot wounds of the thorax consists in the arrest of hemorrhage, the removal of foreign bodies, the disinfection of the wound, the withdrawal of the fluid from the pleural cavity, the management of the fractures involving the vertebræ, ribs, or sternum, attention to the injured diaphragm, and the alleviation of the symptoms arising from associated abdominal lesions.

The arrest of primary hemorrhage is effected by a double ligature placed upon the proximal and distal ends of the artery. This method is applicable in the event of a wound of the branches of any of the large vessels upon the surface of the thorax. If the internal mammary or intercostals are torn, it may be necessary to cut away quickly a piece of the rib in order to reach the bleeding point. If the hemorrhage is not alarming, and there is an opening between the ribs sufficient to admit the finger, a small tampon attached to a string can be pushed into the thorax, and then draw out so as to make pressure upon the vessel against the inner surface of the rib. A hemorrhage from the lung-tissue itself can be controlled with a tampon, absolute rest, and large doses of opium.

The *differential diagnosis* between an arterial and a pulmonary hemorrhage is that in the former the blood comes in spurts synchronous with the action of the heart and is bright red in color, while in the latter the blood wells up from the bottom of the wound and is dark blue or nearly black.

A very ingenious method of differential diagnosis between hemorrhage from an intercostal artery and the lung-tissue was devised by Richter, who suggested introducing into the wound a visiting card rendered aseptic and rolled up in the form of a circular tube and bent at an angle, and if the blood flows out along the groove, it shows the origin of the hemorrhage is from the intercostal artery, but if the blood flows out of the wound under the card, the source of the bleeding is from the pulmonary tissue..

The *removal of a foreign body* should be attempted if it is within reach of the surgeon. A bullet or a part of the clothing or a piece of loose rib should be extracted in order to make the wound aseptic. The surgeon should not attempt any deep exploration, and should use his finger, rendered thoroughly aseptic, in preference to a probe. The disinfection of the wound is accomplished by free irrigation of a solution made of sterilized water impregnated with bichloride of mercury of about 1 : 2000 in strength.

The withdrawal of fluid from the pleural cavity is indicated. Blood left in the pleural cavity under such circumstances is not likely to absorb, but to give rise to an empyema. The removal of the fluid prevents a

Fig. 118.

Gunshot wound of the chest (*Medical and Surgical History of the War*).

purulent collection. If after a few days serum collects, it should be dealt with in the same manner. In case fractures of the bones forming the thorax are found as an associated injury, they should be treated as compound fractures occurring independent of a gunshot wound.

Injury to the diaphragm is attended with a peculiar respiration, severe pain, and irregular pulse. The question of abdominal section must be considered, as rents in the diaphragm have been stitched and recovery followed.

The associated injuries of the abdomen must be treated according to the rules which govern the surgeon in the management of these wounds independent of any chest complication.

Gunshot wounds of the mediastinum may occur so that scarcely any visceral injury is inflicted. The accompanying chromo-lithograph shows a case where the anterior mediastinum was freely opened by a canister shot and the contents of the chest exposed to view. The patient recovered, and at the expiration of ten years was alive and apparently well.

Injuries of the thoracic viscera include wounds of the pleura, lung, diaphragm, thoracic duct, the vessels, pericardium, and heart. Wounds of the heart and pericardium are discussed in another chapter.

Wounds of the pleura occur in consequence of fracture of the bones forming the thoracic parietes ; also in cases of severe contusion, in gunshot and stab wounds. The injuries of the pleura complicating fracture of the ribs is discussed in another chapter. The pleura may be ruptured in violent contusions of the chest.

Rupture of the pleura occurs in consequence of a severe blow upon the chest-wall or by a crush. This accident may occur without any visible external wound. If the visceral layer is torn, percussion reveals the presence of localized dulness, and auscultation gives evidence of crepitation. Dyspnœa and cough occur, which in some rare cases are accompanied by bloody expectoration. Blood may escape into the pleural cavity and give rise to hæmothorax ; or air, in which case, pneumothorax develops. The air may be drawn in from the outside if an external wound exists, but the air escapes again at the same opening, and does not cause expectoration of bloody and frothy mucus, as is always the case when the lung is injured. To this condition the term traumapnœa has been given. In some cases both conditions may exist simultaneously. A small localized rent reappears without much disturbance, but a large tear may be followed by a superficial gangrene of the lung, by abscess, or by a unilateral pleurisy.

Rupture of the pleura may also occur as a result of a *fracture* of the rib or of the sternum. It may also appear in consequence of a gunshot wound or a stab wound. The lung may escape injury in some cases, although it is usually complicated with the injury of the pleura. If the lung is wounded as an associated injury, the shock is profound, the respirations are largely abdominal, and expectoration of blood and frothy mucus occurs. If the wound in the chest-wall corresponds to the wound in the lung, a peculiar hissing sound follows, which is caused by the passage of air through the wound into the lung.

The TREATMENT consists in the fixation of the chest-wall by strips of adhesive plaster ; in the diminution of the respiration by the administration of opium ; in the withdrawal of the blood from the chest by aspiration ; and, finally, in the judicious employment of stimulants. If a compound fracture exists, the wound must be rendered aseptic and the bullet and any foreign body removed if within reach.

Hæmothorax and **pneumocele** are likely to develop in consequence of the injury of the pleura. The former occurs from rupture of the lung itself or of the internal mammary or the intercostal arteries, and the latter from hernia of the lung through the tear in the pleura. When this latter condition arises, the term pneumocele or hernia of the lung or prolapse of the lung is used.

The pneumocele may occur at the time of the injury, or subsequently by pressure of the lung against a weakened cicatrix.

Pneumocele is rather a rare sequela in penetrating wounds of the chest, since in 20,000 cases of chest wounds only 5 were followed by pneumocele. The most

frequent seat of pneumocele in punctured and stab wounds is upon the anterior part of the chest. Occasionally the wound is situated low down, so as to be complicated with hernia of some of the abdominal viscera.

If the pneumocele be primary, the parietes are injured, and the lung is forced out by a violent act of expiration with the glottis closed. The section of lung thus protruded may be returned if seen soon after the occurrence of the accident; if not, the hernia cannot be returned, owing to the enlargement of the mass due to congestion and inflammation. In very exceptional cases the pedicle may become more or less strangulated. The mass can now be left to slough, or it can be amputated by Paquelin's cautery and the wound left to heal by granulation.

Instead of the peritoneal sac, as in abdominal hernia, the pneumocele may be surrounded by the pleura, which thus forms a serous covering.

If the pneumocele occurs *secondary* to an injury, the hernia does not present for some time. The tumor has a peculiar crackling feeling under the skin, which in this variety is usually intact, and auscultation reveals the presence of air in the pulmonary vessels. The tumor increases in size on expiration, and diminishes during the act of inspiration. The percussion-note is resonant and the respiratory murmur is intensified. The escape of the hernia may be due besides to a weakened cicatrix, to a rupture of the intercostal muscles, or to some degenerative changes in the muscular wall. The writer has under observation a case of pneumocele the result of a stab wound. The hernia gives rise to no unpleasant symptoms, the patient wearing over the tumor a small compress which prevents it from enlarging and protects it from injury.

Rupture of the lung has occurred without any external injury of the chest-wall. The injury is serious, and is accompanied by emphysema, by pneumothorax, by hæmothorax, by hæmoptysis, and sometimes by empyema. Pleuritis and pneumonitis have also followed rupture of the lung. Gosselin believes that at the time of the accident the lung is fully distended with the glottis closed, so that the lung is incapable of yielding and rupture of the organ occurs.

Ashhurst collected 39 cases of rupture of the lung, excluding gunshot injuries, with 12 recoveries, and Otis, 25 cases with 11 recoveries.

In cases of injury to the lung the danger is not so great from the consequences dependent upon the trauma of the lung itself as upon associated injury of the viscera.

Hilton has described "Cases of Rupture of the Pulmonary Tissue" in which the air enters into one of the mediastinal cavities, notably the posterior, and then passes along the course of the nerves and blood-vessels into the neck and axilla. The air even passes downward along the sheaths of the blood-vessels until it reaches the lower limbs.

Wounds of the intercostal artery are by no means trivial, since, according to the Surgeon General's report of the Civil War, 11 out of 15 cases, or 73.4 per cent., had a fatal termination. This high rate of mortality is not to be wondered at, since the intercostal artery can pour out four pounds of blood into the pleural cavity. The vessel can be ligatured near the vertebral column before the artery bifurcates, or one of its branches can be secured after the bifurcation along the inner surface of the rib. The vessel is usually injured by a gunshot wound complicated by compound fracture of the rib. The ligation of both ends is necessary, and the compound fracture of the ribs dressed aseptically, and aspiration of the pleural cavity if that sac is filled with blood.

Many devices were employed to arrest hemorrhage from this vessel, but these have at the present time only an historical interest. Girard suggested enlarging the wound sufficiently to pass a curved needle around the rib and to the thread attach a compress, and draw it against the inner surface so as to compress the vessel. Reybard suggested a curved blunt-pointed needle which also made compression.

Henermann employed a staphylorrhaphy needle. Lotteri used a steel button, and Quessnay utilized an ivory plate for the same purpose. All of these methods are objectionable, because they are likely to produce suppuration in the wound and injure the pleura, and be followed by secondary hemorrhage. If any means is employed besides the ligature, an antiseptic compress is the only safe measure. The compress can be introduced through the wound into the chest, and the tampon drawn outward against the rib. The gauze can be used like the finger of a glove, and then the pocket packed and drawn against the rib.

The **internal mammary artery** has been injured as a result of gunshot and stab wounds. The wound of this vessel derives its chief importance not only from hemorrhage, but especially from associated injury to the pleura. This complication gives rise to hæmothorax. The artery has been injured by a sabre in which the point glided off from the sternum and perforated the intercostal space.

Langenbeck mentioned to the writer that he had seen 5 cases of injury of this artery as a result of duels among the students in the University of Göttingen. Of this number, 2 died and 3 recovered: Langenbeck also stated that up to 1876 there never had been a successful ligation of the internal mammary artery.

The SURGICAL ANATOMY of this artery is important in relation to its ligation. The internal mammary artery comes off from the subclavian artery at a place corresponding to a point between the two heads of the sterno-cleido-mastoid muscle and directly opposite to the thyroid axis. The vessel rises parallel with the sternum one centimetre from its edge, and has the vein on its inner side between the artery and the edge of the sternum. In the upper two intercostal spaces the artery lies on the pleural sac, and if injured in this part of its course the pleural cavity is in all probability opened. In the intercostal spaces below the second the pleural cavity need not be necessarily opened, and, as a matter of fact, is not in wounds of the internal mammary, since the triangularis sterni muscle is between the pleura and the artery. It thus follows that if the artery is wounded above the third intercostal space, the pleural cavity is opened; if below the third interspace, it probably escapes injury. Tamponing the wound above the third interspace is therefore impossible, while this procedure can be carried out below the third intercostal space on account of the triangularis sterni muscle.

The PROGNOSIS in wounds of the internal mammary artery has been most unfavorable, since Voss collected the cases and showed that the mortality is as high as 68 per cent. This high death-rate was largely due to secondary septic inflammatory processes, and in nearly all of these complications antiseptic surgery will relieve in the future.

Secondary hemorrhage is responsible for many deaths after injury of this artery. Billroth had a case of secondary hemorrhage from a wound of this vessel as late as the fifteenth day, but fortunately the bleeding was controlled.

Volkmann had a fatal case of secondary hemorrhage into the pleural cavity upon the ninth day. Palmer lost a case of secondary hemorrhage as late as the fifty-fourth day.

The DIAGNOSIS of injury of the internal mammary artery, if the lesion is situated above the third intercostal space, includes dyspnœa, choking, and hæmothorax. If below the third interspace, the respiratory symptoms are absent.

The diagnosis of injury of this artery is attended with no difficulty if the blood flows out toward the surface, but it is often extremely difficult to determine this injury if the hemorrhage is internal. Under these circumstances rapid anæmia, the situation of the wound, and the signs of lung compression from blood are the points which the surgeon considers as aids to diagnosis.

The TREATMENT of injury of the internal mammary artery consists of ligation of the wounded vessel. If the hemorrhage is primary, the wound in the vessel should be found, and the artery completely divided and both ends ligated. If the hemorrhage is secondary, the artery should be exposed in the next intercostal space above the wounded point, and the vessel tied in its continuity. It has been necessary to resect a portion of the rib in order to reach a wounded vessel.

The technique of ligation of the internal mammary consists of making an incision parallel with the ribs and in the centre of the intercostal space at right angles to the outer side of the edge of the sternum. The skin, fascia, pectoral muscle, and intercostal muscle are all divided and the vessel exposed. The artery runs one centimetre to the outer side of the sternum, and has the vein between it and the border of the sternum.

Langenbeck suggested another incision parallel with the artery, and at the point of election of ligature made a horizontal incision at the upper termination of the vertical incision. This T-incision affords more room to the operator. The pleura must not be injured when the resected portion of the rib is lifted from beneath by an elevator. The edge of the rib must be made smooth, so that no ill consequences may follow from the sharp edges of the divided rib. The hæmothorax must be relieved by incision below, and a drainage-tube can be introduced above through the original wound, now enlarged by a partial resection, and carried into the pleural cavity and out of the chest at the point below where the wound was made, to afford drainage for the blood contained in the pleural cavity. The pleural cavity can be irrigated through the tube, if necessary, by an antiseptic solution.

Injury of the **thoracic duct** occurs in consequence of stab and gunshot wounds, and also as a result of contusion of the thorax and fracture of the vertebræ and ribs. The duct has been ruptured by dilatation as a result of pressure of an abdominal neoplasm; also from stenosis of the duct the result of inflammation. If the wound has an external opening, a whitish fluid escapes, which upon analysis proves to be chyle. The fluid has been known to escape into the pleural cavity, and that cavity tapped upon the supposition that an empyema existed. An important clinical sign as to the character of the fluid is its coagulability upon exposure to the external air and its milky appearance if removed during the process of digestion.

Wounds of the pericardium may occur as a result of fracture of the ribs or sternum, but they are generally produced by a stab or bullet wound. The injury is serious on account of the mechanical pressure of the blood upon the heart.

Paracentesis pericardii should be performed if the diagnosis be certain of hemorrhage into the sac: ice applied over the pericardium has been suggested in conjunction with the administration of opium, and only sufficient cardiac stimulants to prevent heart failure. Over-stimulation is of course attended by fatal results. The place to perform paracentesis pericardii is in the fifth intercostal space, just to the left of the sternum.

Wounds of the heart may be caused by traumatism, as a gunshot or stab wound, or by perforation of a fractured rib. These wounds are not necessarily fatal.

The SIGNS of a wound of the heart are great pain, cardiac syncope, hemorrhage into the pericardial sac, flatness upon percussion over the pericardium, with an increase of the limits of the sac and diminution of the heart-sounds. Death may occur in consequence of mechanical pres-

sure upon the heart by blood in the pericardium or paralysis of the heart-muscles owing to injury.

The TREATMENT of wounds of the heart consists in preventing cerebral anæmia by lowering the head; in affording relief from pain by the use of opium; in stimulating the patient with judgment, since overstimulation is attended by quickly fatal results; and, finally, in increasing the bodily temperature by the application of artificial warmth.

Rupture of the heart is a fatal injury. Gamgee collected 28 cases, in 9 of which there was no injury of the thoracic wall. In about 14 of the cases the pericardium was uninjured. The right ventricle was ruptured by traumatism, while the left ventricle was ruptured by other causes. In all of the causes of rupture there was found to be fatty degeneration of the heart-muscles. Rupture has occurred during tetanus or on account of an embolus or a thrombus of the coronary arteries or its branches; also by an abscess involving the muscular walls of the heart; or, finally, by the escape of blood from a ruptured aneurismal sac.

In traumatism of the upper part of the vertebral column or in diseases or tumors of the segments of the cord itself there are present certain nervous manifestations which affect the thorax. These phenomena should be studied, because upon an accurate interpretation of them a diagnosis of the lesion and its situation can be established. They appear immediately in case of fracture or dislocation or foreign body, a short time after the injury in case of hemorrhage, and a long time after the beginning of the cause in case of disease or tumor. (*Vide* page 88.)

In the case of disease or tumor the onset is therefore slow and gradual, while in hemorrhage it is shortly after the injury, and in fracture and dislocation immediately upon receipt of the traumatism.

EMPHYSEMA.

This condition arises in consequence of the *escape of air from the pulmonary organs into the subjacent subcutaneous tissues.* The emphysema may occur as a result of a wound of the lung produced by mechanical violence or by a stab or gunshot wound. Emphysema may occur also without an injury to the lung, in which case the air is sucked in through a valvular skin-wound from without into a wound in the pleura during the respiratory acts. This condition gives rise to a pneumothorax, the physical signs of which are the same as are ordinarily found. On the other hand, an emphysema may arise in consequence of a rupture of some air-vesicles in the lung and the pleura be uninjured. This variety of emphysema usually affects the mediastinum, and then the cervical region, and is the result of a sudden violent compression of the chest-wall.

The condition may be so extensive that the patient's features are obliterated and the act of respiration seriously impaired. The writer has observed the emphysematous crackling in the scrotum from an injury to the lung. The air seldom if ever extravasates in the subcutaneous tissue of the scalp or in the palms of the hand or the soles of the feet. The air is forced along between the planes of connective tissue by the action of the muscles. Associated with emphysema is usually hæmoptysis.

Emphysema may occur as a result of sepsis, in which case the bubbles of gas are generated in consequence of putrefactive changes. Emphysema may also occur from the escape of intestinal gas as a result of a wound in the intestine.

Emphysema may finally be caused by a valvular skin-wound, in which case the air is sucked into the subcutaneous tissue, and cannot escape from the opening on account of the closure of the valve.

In the traumatic variety, due to an injury of the lung or pleura, the PROGNOSIS is not necessarily serious, since the air soon becomes absorbed. If the extravasation is very extensive, so as to endanger the integrity of the skin or to produce symptoms of suffocation, incisions are indicated. This operative interference, however, is never to be resorted to except in extreme cases, as phlegmonous inflammation and death have followed simple incisions. If the operation is performed, it should be under the most rigid antiseptic precautions.

In septic emphysema the prognosis is not so favorable, since the condition denotes a very intense variety of sepsis.

The TREATMENT consists in combating the sepsis by the application of the principles of antiseptic surgery.

In intestinal emphysema the prognosis is most unfavorable, and the only treatment is an immediate laparotomy. The wounded gut should be sutured and the peritoneal cavity washed out under the most strict antiseptic precautions.

INTERCOSTAL NEURALGIA.

This has been treated by surgical interference. Von Nussbaum suggested and carried into practice the operation of stretching the nerves. In one case he exposed by incision the eighth, ninth, and tenth intercostal nerves. The incision began 6 cm. from the vertebral column, and was carried 6 cm. through the integument, fascia, and the intercostal muscles. The nerve was then isolated, as it accompanies the artery and vein. In another case this same operator cut down upon the eighth, ninth, and tenth intercostal nerves upon both sides in front between the xiphoid cartilage and the umbilicus, and upon the outer edge of the rectus abdominis. In performing the operation he wounded the peritoneum upon the right side, but the case terminated favorably.

THE THORACIC WALLS.

The diseases of the bones and cartilages of the thoracic parietes include *caries* and *necrosis, periostitis, osteomyelitis,* also *chondritis* and *perichondritis.* These processes may arise in consequence of syphilis, tuberculosis, scurvy, and the infective fevers, notably typhoid. Any of these conditions may give rise to sinuses which become tortuous.

The TREATMENT consists of opening up the sinus down to the bone, and, if the latter is diseased, scraping the bone as well as curetting the sinus itself. The track of the sinus should be packed with iodoform gauze, so as to permit the wound to heal by granulation from the bottom.

In addition to acute abscesses and phlegmonous inflammation, cold abscess is often found upon the thoracic parietes. As this variety of abscess is associated with tuberculosis, there is danger of a general infection. The abscesses should be opened, irrigated, curetted, and drained. Injections of a solution of iodoform and glycerin are found useful, as well as a solution of the bichloride of mercury, after which iodoform powder should be dusted over the abscess and into the cavity. These abscesses may occur independent of any bone lesion.

It must be borne in mind that abscesses upon the thoracic wall have been known to perforate an intercostal space and burrow their way into

Fig. 119.

Erosion of sternum, the result of pressure of an aneurism (Wood Museum).

Fig. 120.

Erosion of vertebræ, the result of pressure of an aneurism (Wood Museum).

the lung itself. Under these circumstances the pus is expectorated. In these cases there is no purulent collection in the pleural cavity, and

the external abscess disappears by absorption from the surface of the thorax.

Caries of the ribs or cartilages, or even periostitis, has been known to give rise to a pleurisy or abscess of the lung by propagation. The pleuritic effusion is caused by the conveyance of germs from the seat of disease through the lymph-channels direct to the pleura. The same may be said of inflammatory affections of the diaphragm as well as of diseases of the liver.

The bodies of the vertebræ, as well as the sternum itself, are often eroded in consequence of the pressure of an aneurism. In case of perforation of the sternum the sac protrudes, and some of the signs are identical with those of abscess of the thoracic parietes. This mistake must not be made, as an incision into the sac upon the supposition that the tumor is an abscess would terminate in instant death.

Subphrenic Abscess.

Subphrenic abscess was first described by Barlow in 1845. Hilton Fagge collected several cases, and, following his article, Leyden and Beck have published classical monographs upon the subject. Von Volkmann in 1879 demonstrated that purulent collections beneath the diaphragm could be treated by surgical interference.

Fig. 121.
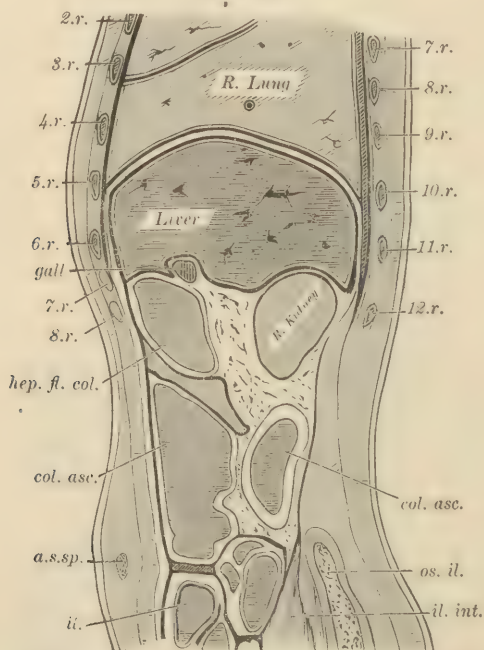
Relations of the thoracic and abdominal viscera (Beck).

The CAUSES of subphrenic abscess are connected with traumatisms of the diaphragm, also with lesions of the stomach, notably ulcer; also with disturbance of the kidney, especially the left, since this organ is higher upon that side.

The pneumococcus has been demonstrated to be a common cause of sub-phrenic abscess. Perforation of the cæcum has likewise given rise to this variety of abscess, as well as perforation of the small intestine, notably the ilium. There are a few cases reported in which the echinococcus was the exciting cause. Abscesses connected with Pott's disease when situated in the corresponding seg-ment of the vertebræ have given rise to this special variety. Weir reports cases in which the disease was secondary to appendicitis. In these cases the pus has forced its way upward between the liver and the diaphragm. Janeway reported two cases produced by carcinoma of the pylorus, and several cases have been collected showing the origin of the disease due to an ulcer of the duodenum.

The SIGNS AND SYMPTOMS of subphrenic abscess vary according to the origin and special variety. The history of the illness leading up to the development of the abscess must always be considered.

If the abscess be due to a gastric ulcer, disturbances indicative of that lesion have preceded its development; if to echinococcus, the his-tory of that disease precedes the formation of the abscess beneath the diaphragm; if to abscess of the kidney, examination of the urine may throw some light upon the diagnosis. Usually the abscess if situated upon the anterior surface of the kidney gives rise to swelling, pain, tenderness, and collateral œdema in the abdominal wall.

If the abscess be the result of a perforation from the pleural cavity downward, the signs of pleuritic effusion and empyema precede the signs of presence of pus beneath the diaphragm (Fig. 122). The explor-ing needle will afford valuable infor-mation as to the character of the fluid. If it is subjected to micro-scopical examination, the presence of special germs like the pneumococ-cus, echinococcus, or bacillus tuber-culosis throws some light upon the etiology and diagnosis.

Fürbringer has called attention to the motions which are communicated to the exploring needle when intro-duced into the abscess-cavity as pathognomonic of this disease.

Weir has called attention to the clinical fact that inspiration increases the outflow of the pus through the cannula in subphrenic abscess, while

FIG. 122.

Thoracic opening in subphrenic abscess (Beck).

the same respiratory movement diminishes the outflow if the purulent collection is in the pleural cavity alone. Mayal has recently called atten-tion to the fact that the manometric pressure may be absent if paralysis of the diaphragm is present.

The PHYSICAL SIGNS are most important. The abscess may be situated upon the right side, as is often the case, owing to the fact that subphrenic abscesses frequently develop from some disturbance con-nected with the intestinal canal, notably the ilio-cæcal valve and the costal and other veins in this vicinity.

Deep percussion elicits pulmonary resonance instead of liver dul-ness, and absence of the respiratory murmur from the third or fourth rib above downward. The line of flatness beneath the diaphragm
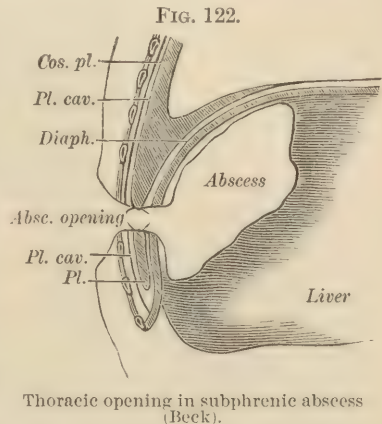
changes according to the attitude of the patient. Succussion can be obtained by placing the ear over the seat of the abscess, then shaking the patient, and the succussion note will be found to be limited to the subdiaphragmatic region.

The absence of cough in connection with purulent collections in the region points to the subdiaphragmatic origin and seat of the fluid as opposed to a pleuritic origin. In some cases perforation of the lung has followed and the pus expectorated. In all cases of purulent collections in this vicinity the expectoration should be microscopically examined.

Litten has called attention to a new diagnostic sign to which he has given the name of "diaphragm phenomenon." This sign consists of a "shadow-like line moving across the chest down and up with exact inspiration and expiration."

FIG. 123.
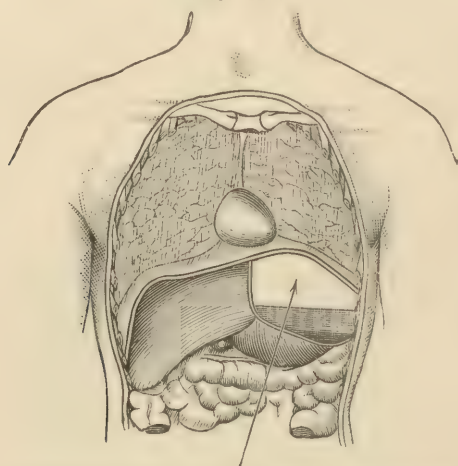
Left-sided subphrenic abscess (containing gas) (Beck).

The TREATMENT *of subphrenic abscess* consists of *evacuation of the pus*, followed by free drainage. When the diagnosis is made certain, free incision should be made, with resection of a portion of the rib if necessary. Beck suggests the space between the eighth and tenth ribs in the mid-axillary line. If the entrance of air into the pleural sac causes dangerous symptoms, the final incision can be postponed for two or three days. Bull in one case stitched the pleural surfaces to avoid infection of the pleura. General anæsthesia may be indicated, but if the pus be near to the surface, the abscess can be opened by the use of the chloride of ethyl and cocaine and the ether spray, combined with free alcoholic stimulation by the mouth. In regard to the irrigation of the abscess after incision, the same rules hold good which have been given in connection with Empyema.

THE MEDIASTINUM.

The *mediastinum* is the space in the median line of the body formed by the non-approximation of the pleuræ. In front the space is bounded by the sternum,

behind by the vertebræ, and upon the sides by the pleuræ. The space is divided into an anterior, middle, and posterior, and, with the exception of the lungs, all the thoracic viscera are found in this space.

The anterior mediastinum contains the origin of the sterno-hyoid, the sterno-thyroid, and triangularis sterni muscles, the thymus gland, lymphatics, and the internal mammary artery of the left side.

The middle mediastinum contains the pericardium with the heart, the ascending aorta, the pulmonary arteries and veins, the superior vena cava, the bifurcation of the trachea, and the phrenic nerves.

The posterior mediastinum contains the thoracic duct, the œsophagus, lymphatics, the pneumogastric and splanchnic nerves, the descending arch of the aorta, the greater and less azygos veins, and the left superior intercostal vein.

The **injuries of the mediastinum** consist of contusions, wounds, fractures, and dislocations of the sternum.

Contusions of the mediastinum may arise from blows and falls upon the chest and from crushing of the thorax. The contusion may be accompanied by a hæmatoma which gives rise to serious cardiac disturbance. If blood collects in the space, aspiration of the cavity is indicated.

The TREATMENT for simple contusion is absolute rest by fixation of the thorax by means of adhesive plaster and by the administration of opium to allay pain and to control the movements of the chest.

Wounds of the mediastinum follow gunshot and stab wounds, and are serious in proportion to the associated injuries of the viscera contained within the space. Hemorrhage is to be treated as described above in connection with Contusion, and the special injury of each viscus is to be dealt with according to rules laid down in connection with injury of each organ. The foreign body should be removed in all cases if possible, and the parts dressed antiseptically and the chest immobilized. Fractures and dislocations of the ribs and sternum are discussed in another chapter especially devoted to this subject.

The great danger besides shock in all mediastinal injuries is that of abscess-formation—a condition soon to be discussed.

Mediastinitis may be either acute or chronic. Acute mediastinitis takes its origin from infection, from cervical abscesses, from caries and necrosis of the ribs, sternum, and vertebræ, from injury such as gunshot and stab wounds, and also in consequence of a fracture of the bones forming the anterior wall of the mediastinum. Inflammation of the mediastinum has been observed in connection with typhoid fever, erysipelas, and measles, and other infectious and contagious diseases.

The SIGNS AND SYMPTOMS consist of substernal pain, which is increased upon coughing or deep inspiration, dyspnœa, cyanosis, localized œdema, difficulty of deglutition, and palpitation of the heart. Fluctuation may exist, and a bulging at the episternal notch and in the corresponding intercostal spaces. Percussion over the mediastinal area elicits dulness, changing according to the position which the patient assumes. Auscultation reveals the loss of respiratory murmur over the area of the abscess.

Chills, rigors, elevation of temperature, rapid and irregular pulse are among the constitutional disturbances.

The general constitution of the patient, the character of the suppuration, and the tendency of the pus to burrow influence the PROGNOSIS.

The TREATMENT of acute mediastinitis consists in affording an

escape for the pus and in irrigation and drainage of the cavity. An incision is made over the most prominent point of bulging through the skin down to the abscess-wall. A trocar and cannula can now be inserted, and a small quantity of pus allowed to escape, the amount of which depends upon the condition of the pulse. Sudden withdrawal of all the pus at once may cause fatal syncope. The drainage-tube can be inserted through the cannula, and the latter withdrawn after the drainage-tube is in place. If the surgeon is unable to reach the pus by incision, trephining of the sternum has been suggested, but it is an operation fraught with great danger, and is only to be resorted to in cases of great gravity. If by pressure of the pus necrosis of the sternum has taken place, a still more serious operation is called for—viz. excision of the sternum. This operation, while called for to save the patient's life, is nevertheless a most serious undertaking. Before cutting down upon the abscess or trephining the sternum or exsecting it the surgeon must be certain that he is not dealing with an aneurism.

Chronic mediastinitis may be caused by pulmonary tuberculosis or from scrofulosis, or be the result of primary mediastinal disease.

The SIGNS AND SYMPTOMS are very similar to those mentioned in connection with the acute variety. The pain may radiate to the shoulder or be transmitted around the chest-wall by the intercostal nerves. This is likely to occur when the pus is found in the posterior mediastinum. The pain may be situated in front of the chest at the termination of the intercostal nerves, from pressure of pus on the roots of these nerves at their origin.

The TREATMENT of chronic mediastinitis consists of aspirating the mediastinum just as soon as the presence of pus is evident. If the pus is found in sufficient quantities to cause bulging of the chest-wall, incision can be made, using the same precautions as have been mentioned in connection with acute mediastinitis. Great care should be exercised if the aspirator is employed, lest any air enter the mediastinum, since this would rapidly convert a chronic into an acute abscess. The withdrawal of only a small quantity of pus at a time must be practised, so as to avoid a fatal collapse. The continuous drainage extending over a short time is the safer method.

The Lungs.

Before describing the surgical diseases of the lungs it is necessary to preface the subject by a few anatomical facts.

The lung itself never completely fills the pleural sac, which explains the absence of dyspnœa in small effusions. This anatomical fact serves to explain the escape of pulmonary lesions in a restricted number of penetrating stab wounds of the chest.

The lung itself also fails to suffer collapse in external injuries if the opposite lung carries on respiration and the accessory muscles are not paralyzed. Williams has pointed out that a sound lung soon expands when pressure of the external atmosphere is interrupted.

Garland in his excellent book on *Pneumo-dynamics* demonstrates that the lung does not "swim upon an effusion, but that, by virtue of its retractility, it supports the entire body of the effusion, together with the diaphragm, until the weight of the fluid exceeds the lifting force of the lung; that the position and shape which the lung assumes when associated with an effusion are determined by the balance

between the weight of the fluid and the elasticity of the lung; that the position and shape which the effusion assumes are determined by the varying degrees of retractility in different parts of the lung and by the position of the patient; that the excess of weight of an effusion is free to act upon the diaphragm according to its specific gravity; that the diaphragm does not bag down until the weight of the effusion exceeds the lifting force of the lung, and the same holds good for the obliteration of the intercostal depression; that the heart, mediastinum, etc. are not pushed out of place by an effusion, whether of air or of fluid, but that those parts are drawn over by the opposing lung. Enormous effusions may of course increase the displacement."

The lung may be the seat of abscess and of **gangrene**, to relieve both of which conditions surgical operations have been performed with success.

Abscess of the lung may result from a pneumonia, from a suppurative inflammation, from the presence of a foreign body, or from a septic embolus derived from a bed-sore or a wound, or an ulcerative endocarditis; from the uterine sinuses; from an otitis media; from tuberculosis; or from a fractured rib or sternum. Abscess of the lung may be also caused by an osteomyelitis of the bones forming the thorax, by a penetrating gunshot wound, by an empyema, or by ulcerating mediastinal nodes; likewise by traumatism and by pyæmia. It may also be caused by syphilis, by bronchiectasis, by extension of an hepatic abscess, by an inhalation or deglutition pneumonia, by puerperal fever, and finally by necrosis of rib, sternum, or vertebræ.

The SIGNS AND SYMPTOMS *of abscess of the lung* consist of a limited unnatural area of dulness, changes in the respiratory murmur, increase in the fremitus, and vocal resonance and bronchial whisper.

The sputum is most offensive, and the pus is greenish or brown in color. Shreds of lining tissue are found under the microscope; also crystals of fat and hæmatoidin and elastic fibres. Septic micrococci are found in the discharge, and the absence of the bacilli tuberculosis excludes the probability, though not the possibility, of tuberculosis.

The presence of pus in the lung gives rise to constitutional disturbance, such as is found in connection with the formation of pus in other parts of the body.

The TREATMENT of abscess of the lung consists in the **evacuation of the pus**, to which operation the term **pneumotomy** has been given.

Before operating the DIAGNOSIS should be made certain and the extent of the abscess mapped out upon the side of the chest. The kidney, liver, and heart should be carefully examined before attempting pneumotomy, and the cavity localized by means of percussion and auscultation and by the use of the exploring needle. There is a diversity of opinion as to the special anæsthetic to be employed. Some recommend chloroform, because the tendency to coughing and vomiting are less. Others prefer ether, notwithstanding these disadvantages, because of its stimulant effect upon the heart. Still, again, others prefer nitrous oxide, since it is the safer of the two anæsthetics. The use of the A. C. E. mixture has also been recommended. Whatever anæsthetic is selected, the cardiac stimulant and oxygen should be at hand, and the hypodermic needles charged so as to permit of no delay in case an emergency arises.

The battery should be in readiness in order to ensure the safety of the anæsthetic in such a case, as in all other capital operations.

Having rendered the field of operation thoroughly sterile, an incision is made down to the intercostal space, and then an aspirating needle is introduced into the abscess-cavity. If adhesions of the pleura to the chest-wall are present, the operation can be completed at one time.

The needle acts as a guide to the surgeon as he cuts into the cavity of the abscess. The incision into the lung can best be made by the actual cautery knife, but very great care must be exercised in the use of Paquelin's cautery if ether is employed. A serious explosion has followed the use of the actual cautery in thoracic surgery; and this fact must be borne in mind.

If the cavity is reached, the pus will flow out through the cannula or through the open wound. The abscess-cavity cannot be irrigated except with very great gentleness, lest the limiting abscess-membrane wall will be ruptured and the fluid be let free to set up a purulent bronchitis. A drainage-tube should be inserted and left *in situ* as long as pus is discharged.

If the cavity is situated unfavorably for drainage, a counter-opening should be made, provided pleuritic adhesions are present.

If after cutting down through the intercostal space no adhesions of the pleura are found, it is best to terminate the operation at this stage and defer its completion until adhesions have formed.

With a view to assisting nature in forming adhesions, Godlee has suggested stitching the lung to the chest-wall, and after waiting a few days finish the operation by cutting into the abscess-cavity. Stitching the lung to the chest-wall is attended with some difficulty, owing to the friability of the pulmonary tissue and the constant movement of the lung on account of respiration, and also owing to the small opening through which the surgeon is obliged to work. Even when this step in the operation is successfully accomplished, the stitches often tear after a few hours in spite of every precaution which has been taken. The opening of the abscess-cavity is made in the manner already described. The adhesion of the pleura to the chest-wall is necessary before the abscess is opened, and if nature has not already accomplished this, the surgeon must wait a few days in order to prevent the escape of even a few drops of pus into the pleural cavity and thus set up an empyema.

The *results of pneumotomy* for abscess of the lung are most encouraging, since there have been 15 cases of complete recovery which the writer collected in two years, and to this number it is safe to say that several have been added. This is a most remarkable showing for a new operation designed to relieve a class of cases which hitherto were almost uniformly fatal.

Tuberculous abscesses of the lung have also been subjected to pneumotomy. These abscesses can be curetted and drained if there is a fistulous opening leading to the cavity or, if the pain is very severe, in those cases in which pleuritic adhesions have formed. It is impossible to cut away enough adjacent pulmonary tissue to remove all the tissue containing bacilli tuberculosis; but fortunately it does not seem always necessary, since the same principle holds good here as in joint tuberculosis. In the latter cases statistics have shown that in resection of a tuberculous joint, even if some infected tissue is left behind, nature will arrest the disease if aided by surgical interference.

Gangrene of the lung may be due to traumatism such as a gunshot or stab wound; from contusion of the chest-wall; from the presence of a foreign body in the bronchus; from an infective embolus; from a

tuberculous abscess; from bronchiectasis; from a pneumonia; and in rare cases from diabetes and bulbar paralysis. This condition may also follow acute interstitial nephritis consecutive to scarlet fever. Gangrene of the lung may also be caused by extension of suppurative processes in the lung, pleura, or diaphragm, or from Pott's disease or infection from bronchial nodes, and, finally, from pertussis. It is seldom if ever a primary disease, but generally secondary to some inflammatory lesion of the lung.

Gangrene of the lung may be diffuse, in which case it is usually embolic, or it may be circumscribed. The diffuse variety does not concern the surgeon, but in the circumscribed form operative interference can be undertaken. The localized gangrene may vary in size from a bean to that of an infant's fist, and it is usually situated upon the periph-

Fig. 124.
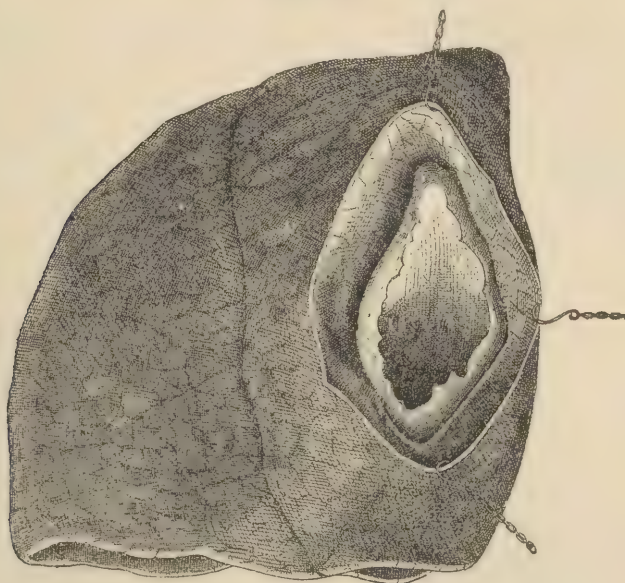
Hydatid cyst of the lung (Riedinger).

ery of the lung, and generally in the lower lobe. In the mass the bacteria of suppuration are always found.

The SIGNS AND SYMPTOMS of gangrene of the lung consist of cough, pain, rapid respiration, with expectoration of a sputum containing pus and necrotic shreds of lung-tissue. The odor from the breath is most offensive. If the sputum is allowed to stand in a glass vessel, three distinct strata are formed. The upper is opaque and frothy and yellow in color, the middle layer is serous, and the lower stratum is green or brown in color. This latter contains necrotic pulmonary tissue with bacteria, crystals of triple phosphates and fatty acids, fat-globules, and pus-corpuscles. Traube has demonstrated that the presence of elastic fibres is characteristic of lung-abscess, together with chills, elevation of temperature, and frequent pulse.

The PHYSICAL SIGNS reveal the presence of a gangrenous area : in some cases the signs are those indicating a cavity.

Fetid bronchitis may be mistaken for gangrene of the lung, but the microscopical examination fails to show the presence of lung-tissue.

The TREATMENT of gangrene of the lung is by pneumotomy, the technique of which is to be carried out practically in the same manner as has already been described in connection with abscess of the lung.

Hydatid cysts may be found in the lung. In 2137 cases of echino-coccus which have been collected from various reports, 212, or 10 per cent., of the cases affected the lungs.

The hydatid cyst in the lung is usually small, and no symptoms of importance are present to establish an accurate diagnosis. If the cyst is large, the signs of intrathoracic pressure are present, and this condition is likely to be mistaken for collection of fluid in the pleural cavity or tuberculosis of the lung. The withdrawal of a few drops of the fluid from the cyst for the purpose of microscopical examination should not be omitted, since the presence of hooklets in the fluid establishes the diagnosis.

The SURGICAL TREATMENT of hydatid cyst involving the lung is called for, since 75 per cent. of the cases terminate fatally. The cyst can be tapped with a trocar and cannula and a few cases of cure have been reported from this simple operation. On the other hand, sudden withdrawal of the fluid has been followed by fatal collapse. If a simple tapping fails to relieve the condition and the fluid becomes purulent, pneumotomy is indicated.

HYDROTHORAX, HÆMOTHORAX, AND PYOTHORAX.

These are conditions which often call for surgical interference. As the technique of the operations for relief is practically the same for all these conditions, one description will suffice.

The SURGICAL TREATMENT of these affections varies according to the peculiar character of the fluid, and consists of thoracentesis, thora-cotomy, and thoracoplasty.

Thoracentesis is an operation by which fluid is withdrawn from the pleural cavity by the introduction of an aspirating needle, a trocar, and a cannula, or by a special instrument known as an aspirator attached to the needle. This operation is to be preferred when the fluid is not purulent, and when the object to be obtained is simply the relief of mechanical pressure upon the lungs.

This operation may also be indicated as a diagnostic test, as the cha-racter of the fluid can be quickly determined after its withdrawal. The signs and symptoms of effusion into the pleural cavity must necessarily depend upon the character of the fluid.

Acute hydrothorax is attended by a serous exudation, and is due to an acute pleurisy with effusion, or it may be secondary to changes in the circulation in consequence of heart or kidney disease. In the latter case it is a simple exudation, and occurs usually as a bilateral affection.

The PHYSICAL SIGNS of fluid in the pleural cavity are—bulging or obliteration of the intercostal spaces, partial fixation of the thorax upon the affected side, and diminution of the expansion of the chest-wall,

dulness or flatness over the affected area according to the position of the patient, with a tympanitic resonance just above the upper limit of the fluid, as pointed out by Skoda.

Upon auscultation the respiratory murmur is diminished and a tubular quality is given to the breath-sounds, and to the voice-sounds a bleating character; diminution or loss of vocal fremitus, displacement of the apex-beat of the heart, and displacement downward of the abdominal viscera in large effusions. In addition to these signs, if the fluid is purulent, there is a septic curve to the temperature, with chills and night-sweats and more or less cachexia. If the purulent fluid has existed for some time, there are signs denoting retraction and compression of the lung of the affected side, with alteration in the shape of the thorax, to which attention has already been directed at the beginning of the chapter.

Thoracentesis is indicated when the fluid in the pleural cavity is sufficient in quantity to produce marked dyspnœa, or when a large quantity still remains, even though medical treatment has been carried out for a long period of time. A most important point to be considered in performing thoracentesis is the danger of converting a simple serous effusion into a purulent one, thus producing an empyema. To avoid this danger the most rigid asepsis must be employed in the performance of the simple operation.

Thoracentesis should be employed as soon as possible after the fluid is sufficient in bulk to cause dyspnœa, since the lung is more likely to expand and the chest-wall to contract, and the relations between the lung, pleura, and chest-wall become normal, under the circumstances of an early tapping. Permanent adhesions of the pleura are also prevented by an early operation. In children this is especially important, and often will effect a permanent cure, because in this class of cases the fluid is due to the presence of the pneumococcus, while in adults the fluid usually contains, besides the pneumococcus, several other varieties of pyogenic organisms.

In children no irrigation is necessary, but in adults, if the bacilli tuberculosis are present, with no bacteria or mixed infection, thoracentesis alone is indicated. A small amount of the fluid can be withdrawn by a hypodermic needle and examined, and if found to contain pneumococci only in children, or the bacilli tuberculosis only in adults, thoracentesis alone is indicated.

If irrigation of the chest is to be performed, the solution should be *warm*, as cold irrigation chills the pleura and severe shock is apt to follow. In a few cases hemiplegia has followed irrigation by cold solutions. This accident has been ascribed to an embolus detached from a venous thrombus—a theory which has been proved incorrect, since in the autopsies no embolus has been found. Another theory is that the hemiplegia is reflex in character, and is caused by some inhibitory action of one-half of the cerebrum. This theory has not been accepted, since the pleural surfaces are insensitive, because they are transformed into the walls of an abscess-cavity. Still another theory has been advanced, that the hemiplegia is epileptiform or uræmic or toxic in character or caused by the absorption of the antiseptic solution. All of these theories have been abandoned, and in their place the theory substituted that shock itself, in the majority of cases, is the cause of the hemiplegia. There are evidently other factors to be considered before we can explain every case of hemiplegia after irrigation with cold solutions.

Broadbent refers to a case in which aspiration was followed by death from cardiac syncope in three or four hours after the tapping. The writer has seen the

same accident occur in a case of aspiration in which the fluid was caused by cancer of the pleura. Gayley reports a case of convulsions followed by sudden death after washing out the chest with a warm solution of iodine and water. Death has followed simple aspiration in the Buffalo clinic. Vallin met with the same accident, and Raynaud lost a patient as the result of irrigation of the chest, death being preceded by convulsions and hemiplegia.

These cases clearly demonstrate the danger of deferring paracentesis until the chest is full of fluid, which causes the formation of thrombi in the pulmonary veins. They also reveal the danger of washing out the chest after aspiration. Early tapping before the lung is compressed and the heart is displaced, and the thoracic circulation is interfered with, offers to the patient the best prospects of cure.

It is a noteworthy clinical fact that the dangerous symptoms have always occurred during the injection of the fluid, and not during its removal.

Before performing thoracentesis the field of operation and the instruments should be made thoroughly aseptic. This is of the greatest importance, in order to avoid the danger of converting a simple serous effusion into a purulent one. The skin over the chest and the axilla should be shaved, washed and scrubbed, and disinfected with a solution of bichloride of mercury or carbolic acid. The instruments, including the needle and tubing, should be boiled and then immersed in an antiseptic solution. The aspirator should also be disinfected. A sterilized rubber cloth should be placed over the chest-wall, and over the rubber, dry sterilized or wet bichloride towels placed. Wet towels should never be placed in direct contact with the chest-wall, since an acute pleurisy is often aggravated by this proceeding, and in cases where operations are performed upon the chest for other reasons a pleurisy might be developed. The surgeon and assistants should thoroughly disinfect their hands in order to ensure a typical aseptic operation. The place where the needle is to be introduced should be sprayed with ether or preferably with the chloride of ethyl, for thus the introduction of the needle is rendered painless. (*Vide* also p. 262, Vol. I.)

Cardiac syncope should be anticipated and prevented by the use of stimulants before and during the operation. The patient can sit in the half-upright position and be supported by pillows, and these can be removed and the patient lowered as the fluid is withdrawn. The recumbent position can be assumed at once if there is any tendency toward syncope. The entrance of air must be prevented, and care must be exercised lest the viscera be injured. The fluid should be withdrawn slowly and only in part, as a sudden withdrawal of the fluid or of the entire amount at one time might be attended by dangerous symptoms and even by death itself. The too precipitate withdrawal of the fluid affects the heart, and the sudden expansion of the compressed lung causes great pain and distress. Coughing or a sudden change in the character of the pulse is an indication to arrest the flow of the fluid, since either of these signs points to a too rapid expansion of the lung and a too violent tearing up of adhesions. The parts should be allowed to gradually accommodate themselves to the vacuum caused by the removal of the fluid. It must be borne in mind that the fluid is not forced out of the chest-cavity as pus is from an abscess-cavity, but by re-expansion of the lung and by the ascent of the diaphragm.

The point of election for the introduction of the aspirating needle or the trocar and cannula is either the eighth intercostal space near the

angle of the scapula, or the sixth intercostal space in the mid-axillary line just in front of the border of the latissimus dorsi muscle, or else at a point where the bulging is the most prominent or the dulness most marked. A small incision can be made in the skin before introducing the needle. The skin is now drawn up so as to form a valve-like opening, and the needle is pushed into the pleural cavity just above the upper border of the lower rib of the elected intercostal space. The free end of the tube, which is attached to a Dieulafoy, to a Potain, or to an ordinary aspirator, or even to Bowditch's suction trocar and needle, should be immersed in a vessel containing an antiseptic solution and placed upon the floor at the foot of the bed. The escape of the fluid from the chest into a vessel containing an antiseptic fluid prevents the danger of entrance of air into the chest. If the flow of the fluid is suddenly arrested, it is doubtless due to a plug of fibrin or lymph or caseous pus in the lumen of the needle. The obstruction can be removed by introducing a stilet rendered aseptic, or by attaching the end of the tube to an irrigator and forcing back cautiously a stream of antiseptic solution into the chest. The amount of fluid to be taken away at one tapping depends upon the character of the fluid and the condition of the patient. If a large amount is present, only half should be removed, and that very slowly. The surgeon should constantly watch the patient's pulse and respiration, and suddenly check the flow in case any change occurs. If the pulse becomes feeble, in addition to arresting the flow of fluid from the chest stimulants should be promptly administered and the patient placed in the supine position at once.

After tapping the patient should be kept perfectly quiet, and the punctured wound hermetically sealed by styptic collodion painted over a thin film of aseptic cotton. The operation may be repeated after a short time if the fluid has accumulated in any great quantity. If the serous discharge becomes purulent, free incision and drainage are indicated in the manner to be presently described. The fluid withdrawn by tapping should be preserved for microscopical and chemical examination. If the fluid is clear and straw-colored, the case is probably one of hydrothorax. This opinion is strengthened by the fact that the fluid contains albumen, a few red and white corpuscles, and epithelial cells. The specific gravity should be about 1010 if the fluid is a simple exudation, and 1020 if an inflammatory effusion. If the fluid is bloody, this fact points to the probable existence of carcinoma or of tuberculosis. The presence of cancer-cells in the bloody effusion confirms the suspicion of carcinoma, and the presence of bacilli tuberculosis of that of phthisis, and the appearance of hooklets of the existence of hydatid cysts.

In cases of pleuritic effusion associated with tuberculosis of the lung the theory has been advanced recently that the fluid should not be withdrawn, for the reason that the pressure of the fluid compresses the lung and prevents it from moving. This action of the fluid is compared to the action of a splint on a tuberculous joint. Le Fevre reports four cases in which thoracentesis was followed by general tuberculosis. This careful observer believes that an intercurrent attack of pleurisy may be non-tubercular, although tuberculosis of the lung is present, and that an attack of acute pleurisy may be the first intimation of pulmonary tuberculosis. The writer has recently seen a case of tubercular empyema in which early tapping and irrigation were not performed. The autopsy, a year later, showed solitary tubercle in the right auricle of the heart, also a tubercle the size of a walnut in the left hemisphere,

which caused Jacksonian epilepsy and occasionally attacks of aphasia ;
also a tubercular osteitis of the spine and a pachymeningitis with a
caseous deposit which caused girdle pains. Early operation might have
prevented general infection in this case, and, judging from a surgical
point of view in a number of cases, the writer recommends tapping and
irrigation and drainage in tubercular empyema.

The fact must be borne in mind that effusion in tuberculosis may be
serous in character, similar to that found in acute pleurisy. Chemical
analysis will show the presence of chyle in case the thoracic duct is
wounded.

Bacteriological examination is of the gravest importance. Search
should be made for the pneumococci, the bacilli tuberculosis, and strep-
tococci.

The PROGNOSIS is more favorable when the effusion is caused by the
pneumococcus, and next by the streptococcus, and least of all by the
bacilli tuberculosis.

Bloody fluid in the pleural cavity points to tuberculosis, but if that
condition can be eliminated primary carcinoma of the pleura or lung is
in all probability present. It must be borne in mind, however, that a
clear serous fluid does not absolutely preclude the presence of a tumor.
The rapid recurrence of bloody fluid after aspiration is a strong argu-
ment in favor of cancer of the lung or pleura, or both.

Prune-juice expectoration is a sign of cancer or sarcoma of the lung
or pleura or lobar pneumonia. The color is due to a decomposition of
the blood and its mixture with frothy mucus. It may also be occasion-
ally observed in tuberculous hemorrhages. It is thus evident that while
this peculiar sputum may occur in tumor of the lung, it also is present
in other diseases of the lung. It is therefore not pathognomonic of tumor,
but only one sign that is often present. The expectoration in tumor
may be purulent or hemorrhagic, or even gangrenous, in character.

Some writers have called attention to **metastatic deposits** in the
lymph-nodes as a diagnostic aid. Behier believed that involvement of
supraclavicular nodes is associated with tumor of the lung or pleura,
whereas involvement of the submaxillary nodes pointed to tuberculosis
of the lungs.

Dyspnœa is a sign of tumor of the lung or pleura, and when these
attacks came on very frequently and there are no physical signs present
to explain the condition, tumor should be suspected. In these cases
aspiration of the chest is not followed by relief as in other conditions,
since the neoplasm itself causes the dyspnœa and not the fluid alone,
and it is but slightly and only temporarily relieved by the withdrawal of
fluid from the pleural cavity.

THORACOTOMY.

Thoracotomy consists in making a free incision into the chest-wall
in order to allow fluid to escape, and afterward to irrigate the pleural
cavity if necessary. It often happens that nature anticipates the sur-
geon and a spontaneous opening occurs, generally in the third intercostal
space a few inches distant from the bone of the sternum. If an exami-
nation of the fluid withdrawn by a hypodermic needle shows the pres-

ence of the bacteria of suppuration, a thoracotomy is indicated. Every antiseptic precaution should be taken, as described under the preparation for thoracentesis. Local anæsthesia is usually sufficient to ensure a painless incision ; the use of the ether atomizer or the chloride of ethyl or cocaine will render the operation painless. Stimulants should be also given according to the directions detailed under Thoracentesis. In exceptional cases general anæsthesia is necessary if a portion of a rib is to be exsected, but great care must be exercised in the administration of the anæsthetic.

The place of election for the incision is in the sixth or eighth intercostal space upon the side of the chest, just anterior to the border of the latissimus dorsi muscle. A point corresponding to the ninth rib and a little external to the angle of the scapula has been suggested by Godlee, while the intercostal space a little posterior to the scapular line, in order to avoid wounding the diaphragm, has been recommended by Hewson. Stokes believes that even the eighth intercostal space is too low. It is not necessary to select the lowest part of the cavity, since the diaphragm ascends during the escape of the fluid from the chest.

The technique of the operation is as follows : The skin should be drawn upward, and an incision two inches in length should be made along the space between the ribs. Retraction of the skin thus affords a valve-like opening. Before the pleura is incised the exploring needle can be introduced if it has not been done before the operation. If pus is found, the pleura can be incised to correspond with the external incision. If the pus is fetid and contains many clots, the pleural cavity can be irrigated with a warm bichloride solution, 1 : 10,000, and followed immediately by irrigation with warm distilled or sterilized salt solution. Washing out the chest must be undertaken with caution, since cases of sudden death have occurred during the irrigation, to which reference has already been made. While washing out the chest the position of the patient should be changed so as to permit the antiseptic fluid to come in contact with all the pleural surface. A rubber drainage-tube with no lateral openings can be introduced, or a silver cannula with a broad flange, either of which must be held in place by some mechanical device. The chest can be irrigated daily according to the temperature. The lung is not apt to expand too rapidly in cases where free incision is made, because atmospheric pressure exists upon both sides.

Beck recommends a resection of a portion of the rib in order to permit the surgeon to introduce his finger with a view to exploration of the pleural cavity and to remove any fibrinous exudation, and also to determine the size of the cavity. After the thoracotomy is completed and the irrigation finished, antiseptic gauze should be applied to the chest-wall and to the mouth of the tube, and over all absorbent cotton. A bandage can now be applied and the dressing changed according to the amount of discharge. The tube should remain until the pus ceases to flow and the discharge becomes serous in character. The wound must not be closed too soon, as this procedure might call for a repetition of the thoracotomy. If the empyema is tubercular, thoracotomy is to be preferred to simple thoracentesis, since the latter permits too rapid expansion of the lung, which act causes tearing up of adhesions and at the same time produces paroxysms of coughing. A pneumothorax or a hæmothorax might thus be engrafted upon a tubercular empyema. Thoracentesis, on the other hand, is recommended in children and in adults when the empyema is not tuberculous. Cauterization of the pleural cavity with a 50 per cent. solution of chloride of zinc has been recommended by Roswell Park.

In tubercular empyema thoracotomy permits the entrance of a certain amount of air from outside, which prevents too rapid expansion of the lung. If the effusion is large, the heart is displaced, and its return to its normal position must not be too sudden, as this might seriously embarrass its action. In children after thoracentesis or thoracotomy pulmonary gymnastics should be practised during convalescence. This can be accomplished by two large Woulff's bottles, one of which is filled with water, while the other is empty. Children are expected to blow the fluid from one bottle into the other, and by this act cause a slow and steady re-expansion of the lung.

In adults, occasionally, these pulmonary gymnastics may be of service.

Empyema may occasionally attack *both* pleural cavities. Garr reports a case of this kind in which he resected a portion of the rib and drained the cavity on one side for four days, then made the same operation upon the other side.

In studying the literature of the subject the writer has collected 10 cases of double empyema, with recovery in every case but 1. Aspiration was performed in 4 out of the 10 cases, and drainage with resection of the rib in the remaining 6.

The operation of thoracotomy, with resection of a small portion of the ribs and drainage, seems to be preferable to paracentesis if the lungs are compressed, since the admission of air from without prevents a too sudden expansion of the compressed lung.

Gould has wisely suggested that in cases of double empyema, in which delay between the two operations seems dangerous, " the two empyemata should be carefully aspirated a few hours before the operation. By this means the shock produced by the sudden removal of pressure from the lungs is obviated, and the simultaneous drainage of the two pleuræ is robbed of its chief danger."

Cantley suggests aspiration on both sides as a preparatory procedure in order to diminish the amount of the fluid and relieve the heart, and upon the following day to perform thoracotomy on the left side, and in a few days to a week later to operate on the right side. He also prefers local anæsthesia to general.

THORACOPLASTY.

Thoracoplasty, or resection of the ribs, was first suggested by Dr. Warren Stone of New Orleans, La. To Estländer is due the credit of establishing the operation as a recognized procedure. The operation is a serious one, and is only undertaken to save life. The mortality depends upon the character of the empyema and the general condition of the patient. This operation is indicated when thoracentesis and thoracotomy have failed in their object, or when a new sacculated empyema has developed, or a rupture in the chest-wall has occurred and an incurable fistula exists. The operation is also indicated when general tuberculosis is threatened, or when the remote effects of the empyema upon the brain, kidney, or lung are serious. All of these conditions preclude the possibility of recovery, because the lung is fixed, which prevents its expansion. The pleura is adherent and inelastic ; the chest-wall is rigid, leaving an unnatural cavity. Thoracoplasty aims to relieve these morbid conditions. Anæsthesia is necessary, and the administration must be conducted with great care. The patient must not be placed too much on the sound side, since the narcosis might cause too much shock or the pus might get into the bronchi of the sound lung and cause

a limited suppurative pneumonia. The number of the ribs to be exsected depends upon the size of the cavity, which can be explored by the finger before the ribs are removed. The dimensions of the cavity influence the size of the flap and the direction of the incision and the amount of bone to be sacrificed. The second to the seventh ribs are usually selected, since they generally correspond to the anatomical situation of the cavity. The first rib is never selected, owing to its anatomical relations with the subclavian vessels. As much bone must be removed as covers the size of the abscess-cavity, and this may vary from one inch to an area extending over the entire osseous structure covering the cavity. A flap shaped like the letter U can be made, with its pedicle upward, as suggested by Godlee; or transverse cuts along the centre of each intercostal space, with removal of the upper and lower ribs in the wound, as recommended by Estländer; or several small flaps, as advised by Jacobson; or a vertical incision, as practised by Gould. Whatever incision or variety of flap is adopted, the periosteum and ribs are removed as soon as the parts are exposed.

The thickened pleura must be cut away and the hemorrhage at once arrested by forceps and ligature.

Fig. 125.

Result of Estländer's operation for chronic empyema (Richardson).

Schede has suggested the resection of all the tissues of the wall except the skin and superficial fascia of the pleura, which are then sewed to the pleura.

Tillmann suggests the application of the curette to the pleura after the resection of the ribs. Warm sterilized water should be used, following the antiseptic solu-

Fig. 126.
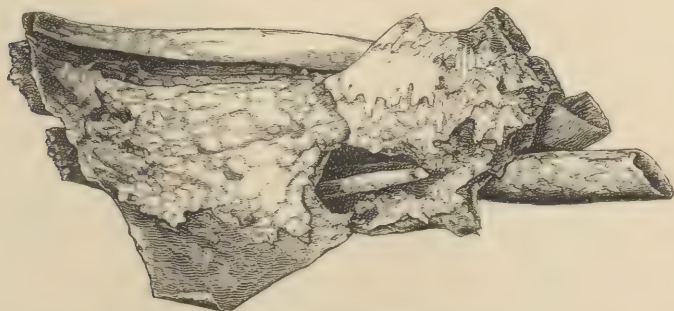
Calcification of the pleura.

tion, to prevent any toxic effects. The flap should be sutured, leaving in a drainage-tube. As the operation often lasts for some time and the condition of the patient is usually feeble, stimulants must be in readiness to use as required. The dis-

charges must be kept aseptic, since a fresh attack might follow in consequence of a new infection. As long as even the smallest fistula exists the danger of new infection must be borne in mind.

Thoracoplasty is indicated instead of thoracotomy when an empyema has existed a sufficient time to cause the lung-tissue or the thoracic parietes to lose their normal elasticity and the pleura to become thickened and infiltrated with granulation-tissue and coagulable lymph. Under such conditions no operation except thoracoplasty holds out any hope of permanent cure to the patient. It is thus evident that thoracoplasty is an operation to save life only in those cases where thoracentesis and thoracotomy have failed to effect a cure, and to offer a hope of recovery in cases hitherto considered fatal.

Calcification of the pleura has been observed in connection with disease of the rib. Fig. 126 illustrates this disease of the pleura, for which no surgical operation can be undertaken unless the lesion is circumscribed. The writer has also recently observed a case of multiple fibroid nodules studding the parietal layer of the pleura.

Tumors of the Thorax.

Tumors of the thorax may be situated upon the thoracic wall or involve the bony parietes, the viscera, or the mediastinal nodes. Gurlt collected 14,630 tumors from several hospitals, and of this number 104 grew from the thorax.

The neoplasmata affecting the external surface of the thorax may be benign or malignant. The former class includes lipoma, fibroma, chondroma, osteoma, neuroma, and the latter sarcoma and carcinoma. The benign growths may take their origin from the soft parts. It is of the greatest importance to distinguish between those which grow from the external parts and those which take their origin from within and present externally by forcing their way through the chest-wall. The question should be carefully considered before undertaking any surgical operation.

The tumors that most likely arise from the external soft parts are the lipomata, which grow from the subcutaneous fatty tissue which abounds so plentifully upon the back and sides of the thorax. The lipoma in this situation is generally pedunculated, attains only a moderate size, and is freely movable under the skin, which can be usually gathered up in wrinkles over it. The tumor is painless unless it embraces a nerve-filament or becomes inflamed.

Lipoma is the most frequent benign growth which is found upon the thorax. It is usually situated upon the back of the chest, notably between the scapulæ, and takes its origin from the fatty tissue which appears in such abundance in this situation. Billroth reported the removal of one from this situation which was equal in weight to about one-third of the body.

Lipomata are occasionally found upon the front of the thorax, and especially behind the mammary gland. These retromammary lipomata have been known to cause death by causing hypertrophy and dilatation of the heart. These lipomata, on the other hand, have grown outward, and caused by pressure an ulceration of the skin upon the front of the chest. Small multiple lipomata springing from the subcutaneous adipose tissue are often observed, and Le Gros Clark reports having

PLATE VII.

Neuro-fibroma of Skin.

removed a lipoma which was situated beneath the pectoralis minor muscle. The writer has frequently seen a case of multiple lipomata of the chest with a large lipoma situated upon the buttocks, the size of which exceeded that of the man's head.

Fibromata are also found upon the chest-wall. They are of two varieties, one of which is hard and slow-growing and less movable than the lipoma, and springs frequently from the axilla, and also beneath the pec-

Fig. 127.
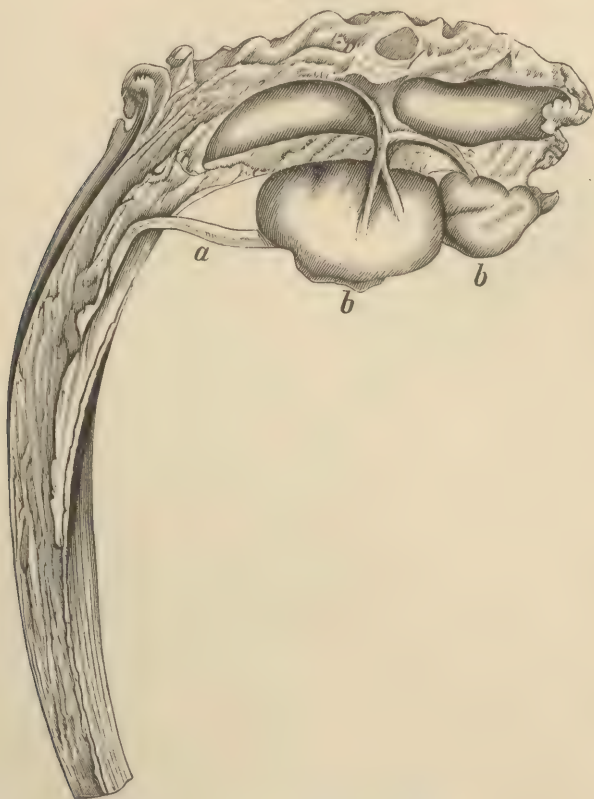
Neuroma of intercostal nerves (Riedinger).

toralis major muscle. The other variety is soft, multiple, and usually congenital, and termed fibroma molluscum. There are no metastases from this growth, although regional recurrence sometimes is found (Plate VII.).

These fibromata may be pedunculated or sessile, and in either case raised well above the surface of the skin.

Keloids are sometimes observed upon the sternum, and occasionally assume the characteristics of the recurrent fibroid tumor of Paget.

Chondroma of the chest takes its origin from the sternum, ribs, and cartilages. The tumor is hard, solitary, painless, and slow-growing unless it partakes of cystic degeneration, and usually occurs during adult life.

The chondroma, if pure, is benign, but, unfortunately, the growth is found to be associated with sarcoma, in which case it is highly malignant. It must not be forgotten that in exceptional cases the chondroma may grow inward and involve the pleura or the diaphragm.

Traumatism seems to explain the origin of chondroma of the ribs, since the tumor has been observed to start from the seat of a fractured rib.

Fig. 128.

Sarcoma of rib and pleura, result of injury by a base-ball.

Neuroma may be found on the chest-wall, and it grows from one of the intercostal nerves.

Echinococcus of the sternum has been observed in a few cases, and also dermoid cysts. They are, however, so rare that they are mere surgical curiosities.

Osteomata grow from the bony structure of the thorax. They are hard as bone itself and do not form secondary deposits.

Sarcoma is found upon the thorax, but usually it has an intra-thoracic origin, having made its way through the parietes. The tumor grows rapidly, soon forms a fungous mass, and causes metastases. In the early stage the growth appears hard and nodulated, and admits of little movement under the skin, which very soon becomes discolored and ulcerates. The growth may appear upon the front or in the axillary region.

The writer has recently operated on a case of sarcoma which was situated upon the axillary aspect of the chest. The patient was fifteen years of age, and was struck over the site of the tumor by a base-ball. Three months later a well-defined, hard tumor was present, with firm adhesions to the rib. The tumor was removed together with the rib to which it was attached, and also the underlying pleura, which was also involved. The lung itself was not implicated in the growth. The accompanying wood-cut shows the appearance of the tumor at the time of operation or three months following the trauma. (*Vide* Fig. 128.)

Sarcoma may grow also from the sternum. The writer has seen several of these cases, but in each case the tumor was situated upon the manubrium and had perforated the bone. It is a question whether these sarcomata grew from the connective tissue behind the sternum and perforated the bone or from the periosteum upon the front of the sternum. In either case the prognosis is not favorable.

Gummata are found on the chest-wall: they appear as indurated swellings just beneath the skin. These tumors appear in the tertiary stage of syphilis. The skin over the swelling soon becomes cyanotic, denoting a disturbance in the nutrition of the skin. This condition soon leads to the formation of an ulcer. In rare cases the ulcers undergo absorption, leaving behind a thickened fibroid mass. In the active stage the mass contains in the centre cells which rapidly undergo fatty change, while upon the periphery of the tumor is a network of blood-vessels, and between this layer and the softened nucleus within is a matrix imbedded in which are numerous cells. The breaking down of the gumma in its interior is attributed to a want of blood-supply induced by thrombosis of the vessels surrounding the periphery of the mass. These gummata may be situated in the periosteum of the ribs and sternum, and even upon the scapula. They usually cause caries of the respective bones. They may also be situated in the substance of the muscles. They are usually unilateral, chronic in their course, and may cause metastasis in the lung.

The ulcers from syphilis are generally situated upon the sternum and form deep excavations leading down to exposed bone.

The TREATMENT consists of the administration of iodide of potash and mercury, conjoined with mercurial baths. Mercury must not be employed to the extent of salivation or in chronic Bright's disease. Under any circumstances the administration of the drugs mentioned must be carefully watched. If the gumma has begun to break down and ulceration is present, the ulcer can be scraped and antisyphilitic remedies immediately employed. The removal may even expose the pleura or pericardium. The use of a bichloride solution for irrigation and the dressing of the base of the ulcer with iodoform are recommended.

Tuberculosis of the chest-wall is occasionally observed. The disease may be present in the form of an ulcer or a cold abscess. If the former is the case, the caseation of the mass usually follows. Some parts of the tuberculous mass may undergo calcification. This breaking down of the tuberculous nodule may be followed by an abscess to which reference has just been made.

The condition calls for radical surgical TREATMENT, since general tuberculosis may follow from this focus. The disease may also produce caries of the ribs or sternum, just as gummata will cause these changes in bones.

The *tuberculous nodule* is situated in the subcutaneous tissue, and from the mass long sinuses lead outward which are lined by unhealthy granulations. The sinuses may be very tortuous and extend for a long distance beneath the skin. Occasionally the tuberculous nodule may take its origin in the subperiosteal instead of the subcutaneous tissue, in which case there is danger of visceral infection.

The TREATMENT of tuberculous ulcers upon the chest call for practically the same local measures as are indicated in gummatous ulcers. Tonics should be employed, but not the potash and mercury as in syphilis. Out-of-door life, physical exercise, and sea-bathing are among the means suggested to improve the general health.

Actinomycosis affects the chest-wall. The disease begins upon the thorax and extends inward until the lung becomes involved. The condition gives rise to a fistula which has been mistaken for tuberculosis. (*Vide* Vol. I. p. 156.)

The SIGNS AND SYMPTOMS of actinomycosis of the chest-wall consist of the presence of a hard lump over which the skin has become cyanotic. The integument soon sloughs and a peculiar discharge containing yellow granules escapes. Into the mass numerous tortuous sinuses are seen, and from these sinuses the characteristic yellow discharge flows. The presence of much liquefaction indicates the activity of the fungus, while granulations springing up point to the death of the fungus.

The TREATMENT of actinomycosis of the chest-wall consists of excising the indurated and sloughing mass and scraping with a curette the sinuses, and then applying the actual cautery. The use of bichloride of mercury as an antiseptic irrigation is highly extolled. Gautier injected a solution of iodide of potash into the indurated mass, and then passed a galvanic current through it. This liberated the nascent iodine into the tumor and destroyed the actinomycoses.

Carcinoma may be situated anywhere upon the front of the chest and also in the axilla. The disease begins upon the skin and ulcerates its way into the deeper tissues. The mode of origin is different from that of sarcoma, which usually begins under the skin and grows externally. The axillary carcinoma is usually secondary to breast carcinoma, although in two instances the writer has seen primary carcinoma in the axillary glands.

The tumor grows rapidly, is attended by pain and cachexia, and soon gives rise to metastatic deposits. The ulcer bleeds, has an irregular edge, and is covered with a discharge. The tumor is usually situated over the sternum, and is immovably connected with the subjacent structures.

The TREATMENT of tumors involving the external surface is early

excision, with removal of the nodes if the growth is malignant. The treatment of tumors of the breast is not considered, for a full description of which the reader is referred to the chapter on Diseases of the Mammary Gland.

The lipoma and fibroma are easily excised. The chondroma occasionally demands removal of the corresponding rib, especially if it grows rapidly, in which case the tumor should be removed by a flap incision. The small, slow-growing chondroma seldom demands surgical interference, and the character of the tumor is such that the risks of an operation are greater than those of the presence of the tumor itself.

Osteoma seldom calls for surgical interference, since it is not malignant and never gives rise to secondary deposits.

In the removal of sarcoma and carcinoma a radical operation is demanded. The growth should be freely excised and any infected nodes removed. In these two varieties of malignant tumors the base of the ulcer should be thoroughly cauterized with a Paquelin cautery. If this is employed, ether must not be used, since an explosion might occur and suffocate the patient.

In concluding the subject of tumors of the outer surface of the thorax the possibility of an aneurism must be considered. The writer has seen two cases of aneurism of the innominate artery which have bored their way through the upper part of the sternum and presented themselves in the form of a tumor having the size of a child's fist. The characteristic signs of aneurism serve to distinguish this tumor from neoplasmata, and the withdrawal of pure blood by an aseptic hypodermic needle will establish with accuracy the diagnosis.

Tumors of the mediastinum are frequently observed. Like tumors of the extrathoracic variety, they may be divided into benign and malignant. Among the former are lipoma, fibroma, enlargements of the mediastinal nodes, together with the dermoid and hydatid cysts, which are not, strictly speaking, tumors, and also the growths connected with the thymus. Among the malignant tumors may be mentioned sarcoma, carcinoma, and lymphoma.

The lipoma and fibroma and the other benign swellings are not, as a rule, susceptible of removal unless they present externally, as they sometimes do, in which case great care must be exercised in their removal. The malignant tumors call for operation if situated in accessible areas.

Sarcoma is the malignant tumor of the mediastinum, which is second in point of frequency, according to Hare, who places carcinoma first.

Sarcoma of the mediastinal nodes may be primary, although it often occurs as a metastatic deposit from the pleura or from the breast or from the abdominal organs. In the latter case the deposits are carried by the blood-vessels or by lymph-channels through the œsophageal opening in the diaphragm. Sarcoma may also affect the mediastinal nodes by secondary deposit from sarcoma of the humerus, while sarcoma of the thigh affects but the lumbar, pelvic, and abdominal nodes. Sarcoma, unlike carcinoma, may affect simultaneously different organs and structures in the body—a clinical fact to be borne in mind as a distinguishing feature from carcinoma. The signs of sarcoma of the mediastinal nodes are lancinating pain, cough, aphonia, cyanosis, dyspnœa, epistaxis, tinnitus aurium, dysphagia, palpitation of the heart with angina pains, œdema of the cervical region due to obstruction in the venous return, dropsy of the serous cavities. Displacement of the heart also occurs, with sometimes œdema of the lower extremities. If the tumor irritates the pneumogastric or phrenic nerves, the usual functional disturbance is present.

The PHYSICAL SIGNS show a marked difference as contrasted with

simple and purulent effusions in the serous cavities or with a chronic non-resolving tuberculous pneumonia.

The DIFFERENTIAL DIAGNOSIS between mediastinal tumors and aneurism is often most difficult, and at times in the early stages of the respective diseases almost impossible, inasmuch as either of the two affections is capable of duplicating any of the physical signs produced by the other.

Carcinoma of the mediastinal nodes presents many signs identical with those just given in connection with sarcoma. This variety of malignant disease stands first in point of frequency. The situation of the tumor is generally in the anterior mediastinum. The disease occurs in adult life, and may be primary or secondary to mammary carcinoma. The disease may originate primarily in the tracheal or bronchial nodes or in the remains of the thymus gland, from the periosteum of the posterior surface of the sternum, or in the abundant connective tissue in the anterior mediastinum.

The tumor has been observed to take its origin even from the pulmonary tissue itself.

The medullary variety is most frequently seen, and next the scirrhous or colloid; the two latter kinds, however, form only a very small percentage of the cases.

The TREATMENT *of malignant tumors* involving the mediastinum consists of removal of the neoplasmata if they are situated in accessible areas. The tumor can be excised if it presents externally by the use of the knife and Paquelin's cautery.

If the tumor is situated posteriorly, it can be removed by a method described by Bryant, for a full description of which the reader is referred to the *Transactions of the American Surgical Association* for 1895.

Sarcoma and carcinoma of the lung are the malignant tumors affecting this organ. The accompanying figure shows a typical carcinoma of the lung. The disease in this case is secondary to carcinoma of the pelvis.

The DIAGNOSIS of malignant neoplasm of the lung is almost impossible in the incipient stage of the growth, since many other conditions at the beginning give rise to similar physical signs.

The only positive means of diagnosis is by an examination of particles of the tumor which have been obtained by expectoration, as in abscess of the lung. This occurrence is extremely rare, since only four well-authenticated cases have been published. Particles of lung-tumor may be obtained for microscopical examination by means of the harpoon. There are two such cases recorded. The examination of the fluid in the pleural cavity has also been employed as a diagnostic test in tumor of the lung. Quincke has demonstrated that the presence of such a pleuritic effusion as hydrops adiposus points to the presence of cancer, since fatty cells seldom, if ever, are found in pure inflammatory exudations, unless occasionally in tuberculous effusions.

Pneumotomy has been employed to remove these neoplasms. It is only when the growth is situated upon the periphery of the lung and the diagnosis is certain that operative interference is justifiable. Andrews of Chicago in 1892 exhibited to the Chicago Medical Society several pulmonary concretions which were removed by pneumotomy.

Tumors affecting the pleura consist chiefly of carcinoma and endothelioma. The writer has seen one case in which the withdrawal of bloody serum twenty-four hours before death was the first evidence pointing to the malignant character of the disease. The condition was thought to be tuberculosis from the physical signs that were present,

especially as the mediastinal and cervical nodes were involved. The pleura may undergo calcification, so that the membrane is rigid, and the process is similar to that involved in calcification of an artery as it is seen in plaques.

Dermoid cyst of the right pleura has been observed, in which the cyst set up an empyema and had a communication with the bronchus, from which the patient coughed up hair. Lipoma has also been observed growing from the parietal layer.

Tumors of the lung are seldom primary. They are usually secondary to malignant disease of the breast. Under the circumstances no operative interference is indicated.

Tumors of the lung consist of *carcinoma* and *sarcoma*. The former is generally secondary to carcinoma of the breast or the mediastinal nodes. Sarcoma is also usually secondary to the disease in some other part of the body.

Tumors of the thoracic duct have been observed. These neoplasmata were secondary deposits from malignant disease of the testicle, uterus,

Fig. 129.
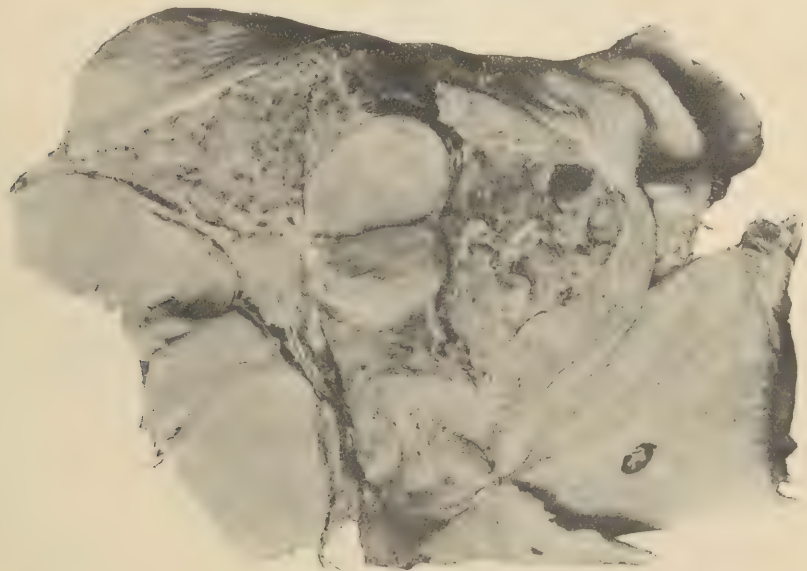
Sarcoma of lung, circumscribed.

and also the lumbar nodes. In one case of carcinoma of the duct the disease was secondary to an undescended testicle.

Tumors of the lungs may be divided into those which are benign and those which are malignant. The benign tumors seldom give rise to symptoms unless they become large enough to mechanically interfere with the function of the lung.

Adenoma has been described by Chiari. Lipoma, chondroma, adenoma, and osteoma are occasionally observed. But these benign neoplasms are chiefly of pathological interest and seldom call for surgical interference. It is often very difficult to decide whether a primary tumor had its origin in the lung and secondarily invaded the pleura, or *vice versâ.*

Gummata are found in the lung in the form of multiple globular nodules.

They may exist for a long time, and if small give rise to no special disturbance. The writer recently examined lungs in which several gummata were imbedded. In a few of the nodules the caseous material in the centre had become softened and broken down, and a distinct fibrous capsule formed of plastic exudation seemed to surround the mass—a condition not usually found in gummata. The capsule was formed of fibrous tissue similar to that surrounding a blood-clot. In these nodules the three characteristic zones were visible—the outer consisting of cells, the middle formed of fibrous tissue, and an inner zone made up of caseous material.

The Diaphragm.

The surgery of the diaphragm can be classified according to the plan pursued in the discussion of the other viscera.

The consideration of the subject embraces the **congenital defects**, the **injuries**, the **disease**, and, finally, the **tumors**.

The diaphragm is a muscle which separates the thoracic from the abdominal cavities. Posteriorly the muscle is attached to the vertebral column, and laterally and anteriorly to the thoracic walls.

Upon the right side the muscle rises to a level with the third cartilage during a forced expiration, and descends to the level of the fifth intercostal space during a forced inspiration. Upon the left side the diaphragm descends to a point a little lower down.

The diaphragm has been observed to ascend as high as the second rib in cases of extreme distention from intestinal tympanitis, and it has been found to descend even below the false ribs in pleuritic effusions.

The muscle has a serous lining upon both its thoracic and abdominal surfaces. In the former case the pleura affords a lining, and in the latter the peritoneum. This anatomical fact serves to explain the peculiar character of the inflammatory affections of the diaphragm.

The **congenital defects of the diaphragm** consist of fissures which permit the escape of the abdominal viscera into the thoracic cavity. The condition is rapidly fatal, since strangulation soon occurs. The accompanying figure shows a case of congenital diaphragmatic hernia in which the viscera have ascended through a fissure in the diaphragm into the thoracic cavity.

Treatment by laparotomy is indicated, provided the diagnosis can be established, but as the infant dies very soon after birth, no operative treatment can be undertaken.

Injuries of the diaphragm consist of gunshot wounds, stab wounds, and rupture.

Gunshot wounds of the diaphragm, as well as stab wounds, present nothing of the interest which attaches to these wounds in other parts. The injury is serious, because the associated abdominal or thoracic lesions render the prognosis exceedingly fatal. Laparotomy is indicated if the diagnosis can be made approximately certain.

Rupture of the diaphragm is caused usually by some form of traumatism, by muscular action, or by the bursting of a liver-abscess. This lesion may occur with or without any corresponding injury to the integument. The rupture occurs, as a rule, through the fleshy part of the muscle, and also, as a rule, upon the left side, because the liver affords protection upon the right side.

The signs of rupture of the diaphragm are a rapid, irregular pulse, which is due to a disturbance of the pneumogastric nerve; a characteristic manner of respiration, which follows an exaggerated action of the

accessory thoracic muscles; quiescence of the diaphragm during respiration; a depression of the epigastric and hypochondriac regions; severe pain and persistent vomiting, both of which are increased by hiccough or coughing. If the stomach or intestine ascends through the torn part, there is an abnormal tympanitic resonance, with a loss of the normal

Fig. 130.

Congenital diaphragmatic hernia (Wood Museum).

respiratory murmur. If fluid is taken into the stomach, a succussion-sound is heard by auscultation. The facies denote severe internal injury.

If the rupture has occurred as a result of the bursting of a liver-abscess, there have been as premonitory symptoms temperature and jaundice. Following quickly upon rupture signs of pleurisy appear.

Tympanitic resonance is heard over this area if the stomach or a coil of intestine has forced its way upward through the rent. The respiratory murmur is altered in consequence of the transposition of the above-named viscera.

Auscultation reveals the presence of a succussion-sound after imbibition of fluid. This sign is very similar to the metallic tinkle pathognomonic of air and fluid in the pleural cavity. Shaking the patient causes the splashing of fluid in the stomach, which can be heard if the ear of the surgeon is placed at this point.

Facial expression is pathognomonic, since it denotes great physical suffering. Following very soon upon these signs, those indicating the onset of pleurisy and peritonitis are observed. In only 10 per cent. of the cases is there absence of a visceral hernia.

The TREATMENT consists in an immediate laparotomy, the performance of which has been successful in at least 8 reported cases. Postempski operated in 1 case in which an omental hernia was present, the reduction of which, together with the suturing of the rent, terminated successfully.

The laparotomy should be performed early, in order to avoid the dangers of the shock of a delayed operation, and also to avert an impending pleurisy and peritonitis.

The diseases of the diaphragm are very few. The chief one is paralysis of the muscle, due to the peripheral lesion of the phrenic nerve. The diaphragm may also be affected in consequence of a diaphragmatic pleurisy or peritonitis, or from toxic influences, such as diphtheria and lead-poisoning, or even from suppuration in the form of a subphrenic abscess, a discussion of which has already been considered. Hysteria may also cause paralysis of the diaphragm.

The SYMPTOMS of paralysis of the diaphragm are loss of movement of the muscle during the respiratory act, an increase in the number of the respirations, a depression in the epigastric and hypochondriac regions, and dyspnœa. Paresis of other muscles is present if the lesion is central, and if this muscle alone is affected, the cause is due to a lesion of the phrenic nerve.

The TREATMENT of paralysis of the diaphragm consists in the administration of iron and strychnia, in galvanism, and in the use of any antidotes to a poison such as lead, or antitoxin in case of diphtheria.

Tumors of the diaphragm are exceedingly rare as a primary affection, although tumors affecting the viscera may cause disturbance which may even lead to rupture of the muscle.

In these cases the SIGNS indicative of rupture are present, but the onset of the symptoms are not sudden, as in rupture due to traumatism.

As the SYMPTOMS develop slowly, the patient becomes more or less accustomed to the altered conditions, and the phenomena are not so well pronounced.

Diaphragmatic hernia may occur in consequence of a congenital fissure or from a tear in the muscle due to traumatism. The injury may be caused by a broken rib or by muscular action. The seat of the laceration is nearer the posterior than the anterior part, and usually upon the left side on account of the presence of the liver upon the right side. The stomach and transverse colon are the parts usually found in the hernial sac.

In addition to the traumatic variety of hernia, a spontaneous variety may occur in which the viscera enter the thoracic cavity through one of the natural openings of the diaphragm. The left side is the usual seat, since the liver occupies by its convex surface the vaulted part of the diaphragm. The opening is generally between the xiphoid cartilage and the costal interspaces.

The SYMPTOMS of strangulated diaphragmatic hernia are those already observed in this condition, together with the presence of a tumor in the thoracic region, accompanied by the signs of dyspnœa.

The TREATMENT of diaphragmatic hernia due to injury is laparotomy, as has already been mentioned. If the hernia is due to congenital defects, no operative interference is of avail. If due to the spontaneous variety, in which the viscera ascend through one of the natural but now dilated openings, laparotomy is indicated, provided the diagnosis can be established.

THE ŒSOPHAGUS.

The *surgical anatomy* of the œsophagus is important in order to understand the operations upon this part. It is a continuation of the pharynx, and begins opposite to the sixth cervical vertebra at the lower border of the cricoid cartilage, and extends downward through the mediastinum and diaphragm to the upper border of the eleventh dorsal vertebra, at which place it enters the stomach. The tube is about nine inches in length, and begins in the median line, and then soon inclines to the left side at the root of the neck. It then returns to the median line, and finally deviates again to the left side to perforate the diaphragm. The narrowest part of the tube is opposite to the fourth dorsal vertebra, although it becomes very narrow opposite the diaphragm.

In the neck, the œsophagus has in front of it the trachea, and a little lower down, where it deviates to the left, the thyroid body and thoracic duct, and behind it rests upon the front of the bodies of the vertebræ upon which lies the longus colli muscle. The œsophagus has upon its side the common carotid artery and the lateral lobes of the thyroid body. The recurrent laryngeal nerve runs in a groove between the œsophagus and the trachea. The surgical relations are of special interest as the œsophagus descends to enter the thorax. The tube descends posterior to the transverse arch of the aorta, and as it passes down through the posterior mediastinum it descends upon the right side of the aorta to the opening in the diaphragm, at which point the tube passes in front of and a little to the left side of the aorta to enter the abdominal cavity.

The œsophagus has in front of it at this point the trachea, the left carotid and subclavian arteries, the pericardium, the left bronchus, and the arch of the aorta. It has behind it the bodies of the vertebræ covered by the longus colli muscle and the intercostal vessels. It has also the aorta behind it in the lowest part of the canal.

Upon the sides the pleuræ cover the œsophagus, and upon the right side is found the vena azygos major and upon the left side the descending aorta. The right pneumogastric nerve passes down behind, and the left pneumogastric in front of the œsophagus. The two vagi, together with the branches coming from the first dorsal ganglion of the sympathetic, form a plexus in front of the œsophagus extending from the root of the lungs to the stomach.

The œsophagus has three coats. The outer or muscular coat is divided into longitudinal and circular layers, between which lies a plexus of nerves. The middle or areolar coat is composed of loose elastic connective tissue in which is imbedded rows of compound racemose glands and adenoid tissue.

The inner or mucous coat is arranged in vertical rugæ or folds, and is covered by pavement epithelium, beneath which are imbedded irregular rows of papillæ.

Between the mucous coat and the middle coat in the lower segment of the œsophagus is a special coat which has been called the muscularis mucosæ.

Malformations of the œsophagus occasionally are observed, and are due to incomplete closure of the branchial clefts. There have been about seventy-five cases reported in surgical literature.

The œsophagus may be entirely *absent*. MacKenzie has reported 14 cases of this kind. The upper and lower part of the canal were present, and the two parts were connected with each other by a cord. In some cases a communication is observed between the trachea and the œsopha-

gus to which the term tracheo-œsophageal fistula has been given. Dilatation of the canal is observed in cases where fatty degeneration of the muscular fibres has taken place.

Dilatation of the œsophagus may be localized, in which case a diverticulum is formed, or it may be general and involve the whole length of the canal. If the condition is not congenital, the cul-de-sac is caused by nature endeavoring to force downward food through a stricture. The pouch is thus formed by a stretching of the œsophageal walls just above the point of obstruction.

Operations have been performed successfully from the neck with a view to obliterate the pouch. The cul-de-sac has been dissected away, and the wound in the œsophageal wall closed with sutures. The pouch is called a pharyngocele. The presence of the pouch is most annoying to the patient, since food often collects in it and gives rise to paroxysms of coughing, and often induces the disagreeable sensation of choking. In some rare cases death has occurred in consequence of choking.

Diverticula of the œsophagus may occur by *distention from within* or by traction *from without*. The diverticulum formed from *distention* is usually found in the extreme upper part, and has been considered a hernial protrusion of the mucous membrane through the separated fibres of the inferior constrictor muscle. This condition presupposes some pathological changes in the walls of the œsophagus.

There are between fifty and sixty cases of this kind scattered throughout surgical literature. In this variety of diverticulum the symptoms are not pronounced until the pouch is distended with food, which enables the patient to swallow with some degree of comfort. Vomiting, regurgitation of food, and dysphagia are common symptoms. The distended diverticulum can be emptied by external manipulation. If this is not done, the food undergoes fermentation and the breath becomes extremely offensive. The passage of an œsophageal bougie will make clear the nature of the trouble. The sound passes into a pouch or sac in the upper part of the œsophagus and becomes arrested, while in case a stricture is present the bougie will pass with difficulty into the stomach and the operation followed by regurgitation of bloody mucus. The obstruction is usually situated lower down, and has present many other signs characteristic of malignant disease.

The *traction diverticula* are seen in adhesions of tumors to the walls of the œsophagus. The development of the growth causes the canal to be pulled aside, and subsequently the walls of the canal and the neoplasm become blended in one mass. Aneurism may also pull the œsophagus to the side, and by dragging upon the walls cause a diverticulum to be formed. This variety of diverticulum is also observed in connection with cicatricial contraction in tuberculosis of bronchial and mediastinal nodes; also from ulceration due to the presence of a foreign body.

In the TREATMENT of these cases little has been accomplished by sounds, special alimentation, and gastrostomy. Recently operations have been performed with a view to excision of the diverticulum, and either closing the wound in the œsophagus with sutures or packing it and allowing it to heal by granulation. Some surgeons suture the œsophageal wound and pack the cervical wound until the danger of extravasations has passed.

The treatment is substantially the same in the second variety of diverticulum, except when ulceration is present, in which case the œsophageal wound cannot be sutured.

Wounds of the œsophagus occur externally in consequence of injuries, and internally by the action of sharp-pointed foreign bodies.

The wounds by external injuries are caused by stab, bayonet, and pistol-shot wounds ; also in cut-throats.

The wounds by internal injuries are caused by the passage of sharp instruments and by foreign bodies. Pins, needles, and dental plates cause ulceration of the mucous membrane. In one case, the specimen of which is in the Wood Museum, a small plate of false teeth was swallowed by accident, and became lodged in the œsophagus and ulcerated through into the pericardium. Œsophageal probangs have injured the walls to such an extent as to cause fatal results.

In external wounds of the œsophagus in which a large opening is made the DIAGNOSIS is attended with no difficulty, but in small wounds, such as stab and gunshot wounds, the precise extent of the injury is often difficult to determine. In the former case the presence of saliva or food in the cervical wound makes the diagnosis positive, and in the latter case regurgitation of blood, intense pain accompanied by hiccough, dysphagia, and dyspnœa make the diagnosis more than probable. The associated injuries, such as perforation of the mediastinum and pleura, or a wound of the bronchial tubes, give rise to special signs pathognomonic of the lesion.

The TREATMENT *of the external wound* of the œsophagus consists in either leaving the wound open, packing it with gauze and feeding by an œsophageal tube, or else suturing the tear in the walls and providing for drainage in the cervical wound by iodoform gauze for a few days.

In the *internal wound* of the œsophagus rest and nutrient enemata are indicated ; but if perforation has occurred, the conversion of the internal wound into a complete external wound and disinfection are the proper methods of treatment.

In rare cases *gastrostomy* is called for, and the patient nourished a sufficient period to allow the wound in the œsophagus to heal.

Rupture of the œsophagus has occurred in consequence of severe vomiting. There are about twenty-five cases reported in surgical literature. It is generally believed that in these cases of rupture the muscular walls of the canal were rendered weak from fatty degeneration.

FIG. 131.

Piece of sausage lodged in œsophagus just below the epiglottis, causing instant death (Wood Museum).

The rent in the canal is usually a linear one and involves chiefly the mucous membrane.

Von Ziemssen and Zenker believe that the walls of the œsophagus are softened by excessive use of alcohol, and that the presence of softening is a necessary condition to rupture.

Rupture of the œsophagus is attended by violent pain, following upon an attack of vomiting, usually to dislodge a foreign body. Collapse at once occurs and vomiting of blood is present. Cervical emphysema appears, and the patient dies in a few hours. If the diagnosis can be made, external œsophagotomy is the proper plan of treatment, but as yet no case has recovered.

Perforation of the œsophagus from other causes than traumatism occurs as a result of peptic or other ulcers, malignant disease, foreign bodies, and from diseases connected with the mediastinum and pleura ; also from pressure of aortic aneurisms.

Fig. 132.

Jack-stone lodged in œsophagus (Phelps).

The TREATMENT must necessarily vary according to the nature of the cause of perforation. An œsophagotomy is indicated for the removal of foreign bodies, and a gastrostomy for malignant disease. In case of ulcer, rest, the use of the stomach-tube or rectal feeding, are among the means to be employed.

Foreign bodies may be lodged in the lower part of the pharynx near the œsophagus. At this place pieces of meat, potatoes, apples, sausage, etc. are arrested on account of their size and volume. In the tonsils and the glosso-epiglottidean fold such foreign bodies as needles, pins, small fish-bones, etc. are often lodged. In every case the pharynx should be carefully examined, since the sensations of the patients are often misleading, as they are under the impression that they have swallowed the foreign body, when it is still caught in the fold of mucous membrane. The opposite condition sometimes prevails, and the patient

thinks the foreign body is still in the throat, when in reality it has passed into the stomach. The bruising and laceration of the mucous membrane cause the same peculiar sensation as occurs when the body is actually impacted in the folds of mucous membrane. For these reasons it is always advisable to examine the throat carefully whenever the accident has occurred, irrespective of the sensations of the patient.

Foreign bodies are also arrested opposite the fifth cervical vertebra and thyroid cartilage, and they may even descend lower in the œsophagus and become lodged in the walls of the œsophagus itself or at the cardiac extremity.

The SIGNS AND SYMPTOMS of foreign bodies in the œsophagus vary according to the place of lodgement. If the body is of good size and is lodged in the upper part of the tube, choking and suffocation are the prominent signs. If in the lower part, the same symptoms are present, and pain is a constant symptom. Erosion of the mucous membrane soon supervenes, and sometimes a slight hæmatemesis follows.

The **removal of foreign bodies** lodged in the œsophagus is often attended with the greatest difficulty. The nature and character of the

FIG. 133.
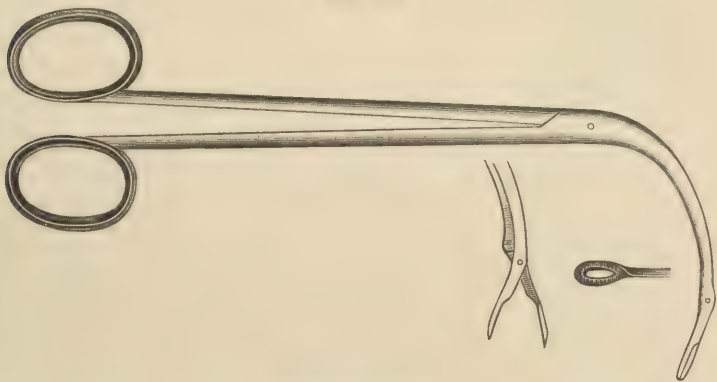
Œsophageal forceps.

foreign body, its exact lodgement in the gullet, and its shape and consistency are points to be considered in all attempts at extraction.

Richardson has demonstrated that a foreign body which is found to be 14½ inches from the incisors is lodged at the cardiac end of the œsophagus; if 9 inches below, it is behind the arch of the aorta. Any foreign body lodged 9 inches from the incisors is in a dangerous position, as Richardson has pointed out, since ulceration into the vessel is imminent.

Foreign bodies may be removed by instrumental means *through the mouth*, by *external incision* or *œsophagotomy*, and, finally, by *gastrotomy*.

Before describing the operative measures a brief mention should be made of the employment of emetics for the purpose of dislodging any foreign body impacted in the œsophagus. As a rule, emetics for this purpose are to be condemned, since perforation and even rupture of the œsophagus have occurred. If the foreign body have no sharp facets upon it and is small, the imbibition of food in the form of a large alimentary bolus has been recommended. This should not be done when the foreign body has sharp edges or is too large to pass through the pylorus or the ileo-cæcal valve. The size of the foreign body is not so important as its shape, and also the fact whether it can be digested by the gastric juice.

Instrumental means through the mouth consist in the use of the œsoph-
ageal forceps, Von Gräfe's coin-catcher, and Sayre's bristle or
umbrella probang. Any and all of these instruments should be
employed with great care, on account of the danger of perforation and
rupture of the œsophagus itself, and also on account of laceration of the
mucous membrane. Attention has been called by Richardson to impac-
tion of the instrument itself, in which case no violence should be
employed, but the removal should take place by a gastrostomy, for a
description of which the student is referred to the chapter on Surgery
of the Stomach.

External œsophagotomy was first performed by Goursault in
1773. The mortality of the operation formerly was very small, and
the results since the introduction of antiseptic surgery are most brilliant.
The incision is made upon the left side of the neck and along the
anterior and inner edge of the sterno-cleido-mastoid muscle just below
the thyroid cartilage. The larynx and trachea are upon the inner side
and vessels upon the outer side. The skin, superficial and deep layer
of the fascia superficialis colli, with the platysma myoides between them,
are first divided. The fascia media colli and the fascia profunda colli
are next divided. The sterno-cleido-mastoid muscle should be pulled
aside and the omo-hyoid muscle divided. The descendens noni nerve
must be protected from injury, as well as the recurrent laryngeal,
which lies in a groove between the trachea and the œsophagus. The
superior and inferior thyroid arteries must also be protected from
injury. A male sound can be introduced through the mouth and the
wall of the œsophagus divided upon the beak. Two curved needles
armed with silk can be introduced through the œsophageal wall, and
the incised wound held apart by an assistant in a manner similar to
that employed in the urethra during external perineal urethrotomy.

The wound in the neck thus held apart by retractors and the incision
in the œsophageal walls by the silk, the interior of the œsophagus is
open to free inspection and instrumental manipulation.

The *after-treatment of the wound* may be conducted by two methods. The first
consists of immediate suture with catgut for the purpose of obtaining primary
union. The second is by granulation, which necessitates packing the wound
with iodoform gauze. Whichever method is adopted, the patient must be fed for
a few days by rectal enemata, or, if by the mouth, through a soft-rubber catheter.
In some cases external œsophagotomy is employed in connection with gastrostomy,
and foreign bodies are dislodged by the combined method, as suggested by
Richardson.

Internal œsophagotomy consists of the introduction of instru-
ments into the canal for the purpose of dividing strictures. The
instruments employed are made after the manner of urethral instru-
ments and are used in much the same way. The operation is fraught
with considerable danger, and nearly 25 per cent. of the cases have
died.

Œsophagismus, or spasm of the œsophagus, is observed in hysteria.
This condition may also arise in connection with some reflex irritation,
such as œsophagitis, or ulceration of the mucous membrane of the canal.
The condition has also been observed in connection with hemorrhoidal
disease or associated with some functional disturbance of the liver. It
has also been observed by Zenker and Ewald in brain and spinal-cord

and kidney disease; also in neuralgia and pregnancy; and finally in cases of inflammation of the œsophagus or stomach and in gastric ulcer.

Œsophagismus differs from any organic stricture in its intermittent character. If a bougie is introduced into the œsophagus, it meets with but little resistance as compared with that arising from an organic stenosis. If food is imbibed, regurgitation occurs immediately, and, in cases of organic stricture, after an appreciable interval. The patient often complains of globus hystericus.

Fig. 134.

The TREATMENT consists of the introduction of the œsophageal bougie at regular intervals. In hysterical patients this operation often relieves the condition. Strychnine and iron and atropine are indicated as tonics, and food which is simple and thoroughly masticated only is to be swallowed. Sea-bathing has also been highly extolled. Faradization has been employed with great benefit.

Stricture of the œsophagus may be due to the presence of benign or malignant tumors, to chronic œsophagitis, to neuroses, to congenital defects, to ulcers, to cicatrices, and to pressure from without upon the tube. Stricture of the œsophagus due to malignant disease will be considered in connection with cancer and sarcoma of the œsophagus.

When the stricture is caused by œsophagitis or by ulcer, rest and rectal feeding are the means to be employed; if due to hysteria, the occasional use of the œsophageal probang, with the internal administration of drugs suitable for the cure of that disease.

As to *congenital defects*, little can be done, as the cases usually die from inanition in a few days. If due to cicatrices, division or divulsion of the stricture is indicated, and finally if to pressure by a neoplasm or an aneurism, nothing can be done if the aneurism or neoplasm cannot be treated. The cicatricial stricture may occur in children in consequence of the imbibition of

Stricture of the œsophagus.

hot soups, or in adults by swallowing caustic alkalies or acids. The dangers of œdema glottidis must be remembered in acute inflammation.

In introducing the œsophageal probang or sound the surgeon must exercise great care and gentleness, less irreparable damage may follow.

The patient should be placed upon a low, firm stool with the head thrown well back. The surgeon should stand directly in front of the patient, and with his left fore and middle fingers introduced into the patient's mouth depress the tongue, and guide the catheter or probang with the right hand along the index finger. As the instrument passes down the pharynx it should be carried a little to the right of the median line at this point, so as to avoid bringing the point against the epiglottis.
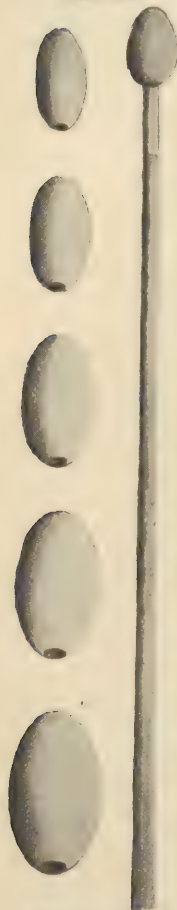
When the instrument has cleared the pharynx it occasionally impinges upon the prominence of the fifth cervical vertebra near the level of the thyroid cartilage. If the slightest obstruction is met with, the patient's head should now be inclined forward, and the probang will enter the stomach without any difficulty.

FIG. 135.

If any stricture exists as a result of malignant disease, the caution cannot be too often repeated that the danger of perforation is very great. In tubercular ulceration of the œsophagus the same warning is pertinent, since the walls are often very thin and a false and fatal passage can be made.

The probang is used to detect foreign bodies and to examine for stricture. It may also be employed to relieve œsophagismus. The catheter is likewise employed for the purpose of feeding the patient in case of insanity or trismus. The soft-rubber catheter has also been used, and in some cases introduced into the stomach through the nostril.

The TREATMENT of œsophageal stenosis consists in the introduction of *sounds* made expressly for this purpose. The instruments employed for this object are probangs with olive-pointed tips (Fig. 135); also steel bulbs, rubber bougies, and flexible hollow sounds. Whalebone guides are also used, and probangs with ivory or sponge tips. The olive-tipped probangs of various sizes are first employed in order to locate the density, the calibre, the length, and general extent of the stricture. The surgeon should begin with a moderate-sized probang, and, finding the stricture, should change to a smaller or larger one according to the amount of resistance. Great care should be exercised lest a perforation is made, as the writer has known this accident to occur and with a fatal termination.

If any shreds of tissue adhere to the instrument, which is especially the case with a sponge probang, they should be carefully preserved and submitted to a microscopical examination.

Œsophageal bougies.

The passage of well-oiled olive-tipped probangs at regular intervals of every few days will dilate a cicatricial stricture or even cure the spasmodic variety, coupled with internal medication consisting of tonics and antispasmodics. A malignant stenosis is in no way benefited by the constant use of sounds. The use of the probang in the latter condition is limited to diagnosis.

Ewald has recommended the hypodermic injection of atropia and morphia before using the sounds, with a view to relaxing the muscles and to diminishing the quantity of saliva and mucus.

The use of dilators like laminaria tents, etc. is open to serious objections, and is mentioned only to call attention to the damage which they inflict.

Retrograde dilatation of strictures of the œsophagus has been

performed by Richardson, Abbe, Murray, Lange, Franks, Loreta, and Schede, to the latter of whom is due the credit of suggesting this method by performing first a gastrotomy.

Paralysis of the œsophagus occurs in consequence of lead-poisoning, alcoholism, and after certain infective diseases like diphtheria. The condition may also result from hysteria.

Œsophageal hemorrhage occurs in connection with cirrhosis of the liver. Garland has recently reported a case in which the patient had repeated hemorrhages during a period of several years until a fatal one occurred. The source of the hemorrhage was from ruptured œsophageal veins surrounding the cardiac end of the canal. The rupture was the result of obstruction to the portal circulation. The writer has recently observed hemorrhage from the œsophagus in a case of obstructive jaundice with enlarged liver. The mouth and pharynx appeared perfectly normal, but the hemorrhage occurred at intervals, and finally disappeared ; but the patient quickly succumbed.

McKenzie reports a fatal œsophageal hemorrhage in a boy suffering from varicose veins.

Malignant disease of the œsophagus consists of *sarcoma* and *carcinoma*.

These conditions are often diagnosticated by means of the *œsophagoscope*, an instrument which is introduced into the pharynx and œsophagus for the purpose of examining the parts. The instrument can also be utilized for the purpose of detecting foreign bodies, as well as various changes in the mucous membrane which eventually give rise to stricture of the œsophagus. The œsophagoscope is used in connection with an electric light. The manipulation necessary to make a satisfactory examination requires the services of one who has had considerable experience in the use of the instrument.

Sarcoma of the œsophagus seldom occurs, since only about half a dozen cases have been reported.

Carcinoma of the œsophagus is the malignant disease of this organ in over 90 per cent. of the cases. The variety most frequently met with is squamous epithelioma. The cardiac end of the œsophagus is the most common seat, although the disease has been found throughout the entire length of the canal.

The epithelioma may be secondary to carcinoma of the stomach or of the larynx or of the pharynx, or even of the tonsils. From these secondary deposits the bronchial and mediastinal nodes often become involved, also those of the trachea and liver. Epithelioma of the œsophagus is also primary, and takes its origin from the mucous membrane, which has become the seat of ulceration in consequence of impaction of foreign bodies, the irritation due to swallowing corrosive poisons, etc. The œsophageal canal may become perforated by ulceration, and an opening established between it and the trachea, or even into the large bloodvessels. The surrounding tissue often becomes infiltrated.

Epithelioma rarely occurs before the thirtieth year of life, and is found most frequently between forty and seventy. Rebitzer states the average period as fifty-eight years. According to Butlin, it affects males more frequently than females, who are affected, as a rule, at an average period of ten years earlier. The disease runs a rapidly fatal course, and the patient expires in about six months from the beginning of the disease. The suffering from dyspnœa, thirst, difficulty of deglutition, and pain is often intense. Occasionally the course is less rapid, but the patient seldom survives eighteen months.

The SIGNS AND SYMPTOMS of epithelioma of the œsophagus are difficulty in deglutition, both of fluids and solids, and, later, regurgitation of solid food, and subsequently fluids if the stenosis becomes very narrow.

Pain is a constant manifestation of malignant disease of the œsophagus, and its intensity increases as the disease progresses. Regurgitation of bloody mucus often follows attempts at deglutition. The shreds of tissue regurgitated should always be subjected to a microscopical examination, as often a positive and early diagnosis can thus be established.

Stricture of the œsophagus soon becomes a serious symptom, and in some cases prevents the passage of all instruments, even though small quantities of fluids are imbibed and pass through the narrow opening.

FIG. 136.
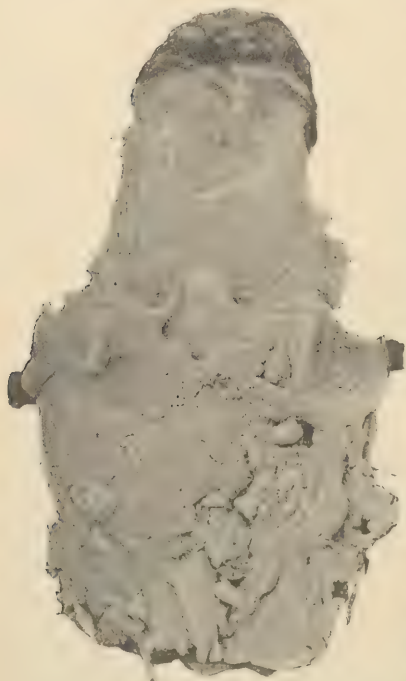
Epithelioma of œsophagus (Wood Museum).

With these local signs certain constitutional symptoms soon supervene, and the patient rapidly becomes emaciated in consequence of loss of food and the constant presence of pain. Inanition is only relieved by a gastrostomy.

The TREATMENT of malignant disease of the œsophagus admits only of œsophagectomy as a radical operation, the mortality of which is very great. Gastrostomy is indicated as a palliative measure in those cases in which an œsophagectomy is impossible. The special technique in connection with œsophagectomy is as follows:

Œsophagectomy consists of excision of a small segment of the œsophagus for the removal of malignant disease.

Czerny, Park, and others have performed the operation on several occasions, but with only partial success, since patients have died a few months following the operation on account of the return of the disease.

The steps of the operation are similar to those already described for external œsophagotomy, and after the segment is removed the lower open end is stitched to the cervical wound. The operation is not considered justifiable except where the segment to be removed can be reached by external œsophagotomy and no metastatic growths are present. The wound should be treated precisely as the wound following œsophagotomy, unless the segment excised is very small, in which case approximation of the ends can be accomplished.

In union of the divided ends the edges must be united like the intestinal canal, and some mechanical device can be employed to help the surgeon.

CHAPTER VII.

SURGICAL DISEASES AND INJURIES OF THE MOUTH, TONGUE, TEETH, AND JAWS.

By Arthur D. Bevan, M. D.

Mouth.

Anatomy and Embryology.—The mouth is bounded in front by the lips and behind by the soft palate and fauces. Its cavity is lined with mucous membrane covered by stratified epithelium. That portion covering the lips and cheeks contains glands of large size, labial and buccal, resembling the salivary glands in structure. These are sometimes the site of *retention-cysts* and other pathological processes. Opening into the mouth are the orifices of the salivary glands. The parotid duct (Stenson's) is opposite the second molar of the upper jaw; the submaxillary duct (Wharton's) on the side of the frænum; and the sublingual ducts (the ducts of Rivini), eight to twenty in number, on the elevated ridge of mucous membrane on either side of the frænum.

The structures bounding the cavity and the mucous membrane covering them are very vascular, and therefore possess a high resisting power against invasion, and for the same reason repair rapidly after injury. The *blood-supply* is derived from the fascial, the internal maxillary, the lingual, and ascending pharyngeal arteries. The *lymphatics* are numerous. The superficial structures drain into the lymphatic nodes of the buccal submaxillary and suprahyoid groups; the deep into those of the internal, maxillary and upper cervical lymphatics. The *nerves* are supplied by the second and third divisions of the fifth pair of cranial nerves and the glosso-pharyngeal.

From its embryological development the mouth-cavity is to be divided into two portions—one the upper end of the foregut, or *primitive pharynx*; the other the oral recess, or *stomodæum*. These are in very early embryonic life separated by a thin septum, which in the normal process of development disappears. An interesting point is that a part of the pituitary body is formed from the original mouth mucous membrane, which in the advancing development becomes entirely shut off from the mouth-cavity. Another point to be remembered is the fact that the central portion of the thyroid body is developed from the mucous membrane of the foregut, and that for a time the thyroid and mouth-cavity, or, at least, the base of the tongue, are connected by an excretory canal, the *thyro-glossal duct*. The remains of this duct are seen normally as the foramen cæcum at the base of the tongue; as an abnormality of development a part of the thyro-glossal duct persists. In the early stages of development the foregut terminates blindly beneath the head; on the external surface of the embryo, in the space between the head and heart, the branchial arches gradually appear, and above these is a depression in the median line, the stomodæum, from which the mouth-cavity and nasal cavities are formed. This depression is surrounded by a number of processes below the mandibular arch, from which the lower jaw and lower lip are formed. Above this, on each side, are the maxillary processes, from which the greater part of the upper jaw and upper lip are formed, and above these, and nearer the median line, the lateral and median nasal processes, from which the intermaxillary bone, the upper lip immediately in front of this bone, the septum, the external nose, and nasal cavities are developed.

The mouth and nasal cavities are at first continuous; later, by the growing together toward the median line of the maxillary processes and the union of the middle nasal processes, the hard palate is produced and the mouth and nasal

cavities separated. If in the process of development the maxillary processes fail to unite, a *cleft* remains, and we have the condition presented called *cleft palate.* This cleft may be complete or partial, and may involve both hard and soft palate or but one or a portion of one of these structures.

The *intermaxillary bone* is formed from the mesial nasal processes : these processes form also the portion of the upper lip in front of the incisors. If this central mass formed by the mesial nasal processes does not coalesce with the maxillary processes, the cleft remaining forms the condition of hare-lip. This condition may be present on one or both sides—in other words, single or double hare-lip. It may be limited to the soft tissues of the lip, or it may include the entire mesial nasal processes, in which case the intermaxillary bone would be entirely separated from the rest of the upper jaw, having in front of it the small mesial portion of the upper lip, and hanging suspended from the end of the vomer. Hare-lip and cleft palate are common : extensive cleft, extending from the mouth to the angle of the eye, occurs, but is rare ; mouths so large or so small as to be classed as malformations are also rare. The foregut is at first separated by a thin layer of epiblast and hypoblast from the stomodœum ; this septum in the process of development disappears and the cavities become continuous ; as a very rare malformation this septum persists and an imperforate foregut is the result. Malformations of the jaws, teeth, and tongue will be discussed under their respective heads.

A clear understanding of the anatomy and embryology of the mouth is essential to the intelligent study of oral surgery.

The study of the bacteriology of the mouth is of great interest to the surgeon. The relationship between mouth bacteria and local lesions of teeth and jaws and mucous membrane, of secondary gastric disturbances, and the study of the mouth as a point of infection for both local and general diseases, is a wide subject, and cannot be freely discussed in this practical text-book. Suffice it to say that normally the mouth contains scores of varieties of bacteria—more than one hundred have been isolated ; that these bacteria are for the most part saprophytic, but include also some common pathogenic forms, such as staphylococcus aureus and albus, pneumococcus, streptococcus pyogenes ; that many of these bacteria have the power of producing lactic acid and decomposition of dead organic substances ; that dental caries is produced by such bacteria ; that pathogenic germs may be normal inhabitants of the mouth without injury to the individual ; that when the resisting powers of the individual or of the local tissues are lowered to a sufficient degree these pathogenic bacteria may find a favorable breeding-ground for the production of disease. The mouth furnishes a point of infection for many pathogenic germs, such as those of diphtheria, erysipelas, actinomycosis, the oïdium albicans of thrush, tubercle bacilli, and the virus of syphilis. It is probable that some of these germs, such as that of diphtheria, may be temporary guests in the mouth-cavity without producing disease, probably finding either the local or general resisting power of individuals such as not to favor their development, and remain innocuous. (See Vol. I. Chapter III.)

The examination of the mouth-cavity can usually be made without difficulty by inspection and palpation. A tongue-depressor is at times of service, a dental mirror is also occasionally useful, and in children a mouth-gag is often required. For this purpose a wedge-shaped piece of wood can be employed or such instruments as Heister's, O'Dwyer's, and Whitehead's gags.

Injuries of the Mouth.—The injuries of the mouth may be *mechanical, chemical,* or *thermic.* Mechanical injuries include incised, lacerated,

and perforating *wounds.* They should be treated as such wounds are in any portion of the body. They demand no special discussion beyond the reminder that the mouth-cavity contains at all times saprophytic and pathogenic bacteria capable of producing infection and decomposition ; because of this fact wounds about the mouth cannot be placed in an absolutely aseptic condition ; mildly antiseptic mouth-washes of boracic acid or bichloride of mercury should be frequently employed to render the cavity as nearly aseptic as possible. *Burns and scalds* of the mouth are not uncommon ; they are, as a rule, of mild degree, and demand nothing in the way of treatment except mild antiseptic mouth-washes. Extensive burns of the lips and the tissues of the face and neck result sometimes in great deformity of the mouth from cicatricial contraction, and require extensive operations for its correction. *Chemical injuries* result usually from the drinking of strong acids or alkalies. If the case is seen soon after the accident, a neutralizing agent, such as soda or vinegar, should be at once applied. The further treatment will be the use of a borax mouth-wash. Chemical injuries of the mouth due to chronic poisoning by mercury, lead, and phosphorus will be discussed under the subject of Injuries and Diseases of the Jaws.

CONGENITAL DEFECTS.

The subject of **hare-lip** will be discussed in the section on the Surgery of the Face.

Cleft palate is a congenital condition, as already explained, due to a failure of closure of the maxillary processes. Defects of palate structure may result from trauma or disease, and demand the same surgical interference. *Congenital cleft palate* may involve both the hard and the

Fig. 137.
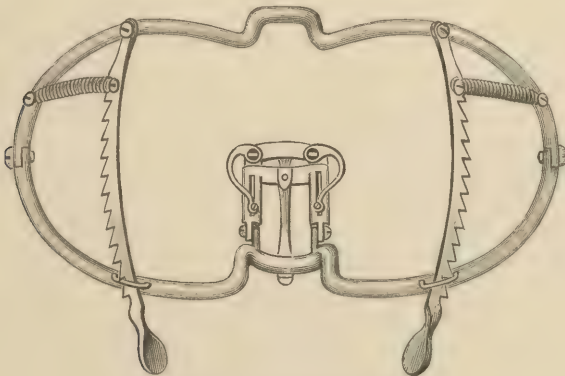
Whitehead's mouth-gag (Dennis).

soft palate, or but one of these structures ; as a rule, both the hard and the soft palate are involved, and hare-lip also exists. The cleft in the soft palate is in the median line ; that of the hard palate, when single, is a little to one side, and when double presents itself as a wide central cleft. The malformation seriously affects the function of speech, giving a peculiar nasal character to the speech characteristic of the difficulty.

The alteration of the normal speech may be so great as to make the speech almost unintelligible except to those accustomed to the individual. This deformity has in some cases a marked effect on the life of its unhappy possessors, sometimes driving them to seclusion. In addition to the interference with *speech*, the cleft permits of the passage of food from the mouth to the nasal cavity, causing irritation and odor from the decomposition of the retained food-masses. *Thrush* often occurs in children with cleft palate. The problem presented by these cleft-palate cases is the closure of the defect so as to correct the speech and prevent the passage of food and drink from the mouth to the nasal cavity. This can be done in two ways—by a **plastic operation** with the purpose of closing the opening, or by an **artificial obturator**. Both of these methods have their advocates, some surgeons advocating the one method to the exclusion of the other. The author believes that both have their use, and should be employed according to the individual case: the artificial obturator finds its special field of usefulness in acquired palate defects, the plastic operation in congenital cleft palate. Operations for closure of cleft palate are divided into *uranoplasty*, the closure of the hard palate, and *staphylorrhaphy*, the closure of the soft palate.

The question as to how long after birth should the defects be closed is an open one. Many surgeons take the ground that hare-lip should be operated upon some time between the third and fifth months, and cleft palate left to the seventh or eighth year. There is a growing tendency to operate very early in these cases, within the first year of life, and there are many arguments to support this view—the fact that the defect in such a case is corrected before the child begins to talk, and the fact that in children who have learned to talk the closure of the defect does not, as a rule, improve the speech. The argument against operating in very early life is the difficulty of ma-

Fig. 138.

Retractors for lips or mouth, with elastic band (König).

nipulation in very small mouths, the greater danger to the patient, and the fact that at seven or eight the after-treatment can be easier carried out than in an infant.

The operation for cleft of the soft palate is done in the following way: The child is anæsthetized, placed in the hanging-head position—*i. e.* with the body on the table and the head hanging over the edge: this position is the best for the purpose of preventing the passage of blood into the trachea; the teeth are held apart by a Whitehead gag; the corners of the mouth held apart with elastic retractors. The edges of the cleft are freshened by a narrow-bladed knife in such a way as to make a broad surface, more tissue being removed from the mouth side than from the nasal or pharynx side. The edges of the cleft are brought together by means of silver wire, silk, or silkworm-gut sutures, placed accurately and closely together, and lastly a myotomy of the tensor palati, and if need be of the palato-glossus and pharyngeus, is made with a tenotome—if there be much tension; dividing the tissue of the soft palate from the centre of each horizontal plate of the palate bone downward and outward to almost the free edge of the soft palate. In case no tension exists, this myotomy can be omitted; the stitches are allowed to remain eight or ten days. In many cases the entire line of approximation will be found to have united; in others, however, failure at one or more points may occur, necessitating a second operation, or, when the

defect is slight, it may heal by granulation or be assisted by touching with silver-nitrate stick or fine platinum cautery. The operation for closure

FIG. 139.
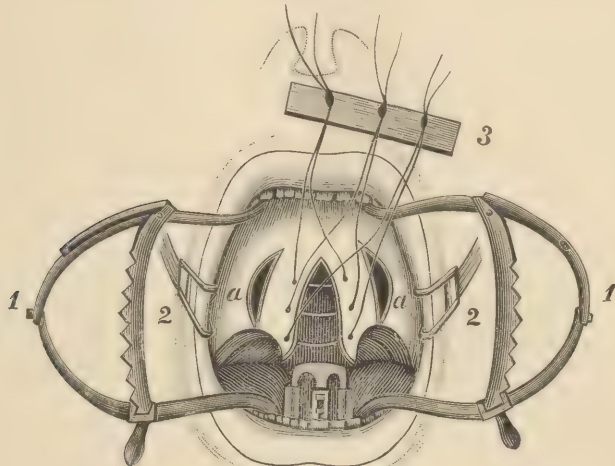
Staphylorrhaphy, sutures placed (König).

of the hard palate—*uranoplasty*—requires anæsthesia, hanging-head position, Whitehead's mouth-gag, and retractors, the same as staphylorrhaphy.

The margins of the cleft are freshened as in closure of soft-palate defect. An incision is then made through the mucous membrane and periosteum close to the alveolar processes and parallel with the cleft; the periosteum is elevated from the bone; and the flap, consisting of mucous membrane and periosteum, is widely freed, so that the edges of the cleft can be approximated without tension. The approximation should be accurate, and the sutures employed should be silver wire or silkworm gut. Silk, however, can be employed, or even catgut, the latter, of course, having the advantage of not requiring removal, but it is not thoroughly reliable. The sutures can be placed by means of a fine full-curved needle and needle-holder. The defect on the bone is covered by granulation, and the periosteum in the flap usually produces bone, closing the cleft eventually with bone-tissue. (*Vide* also Appendix to this chapter.)

FIG. 140.
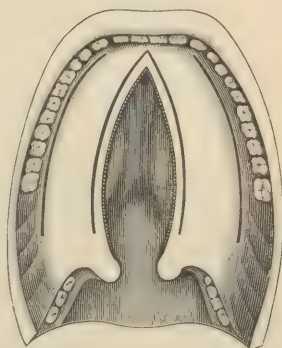
Uranoplasty—showing incisions (Tillmanns).

The *after-treatment* requires considerable attention; a liquid diet is imperative. In some cases it is advisable to introduce a soft-rubber tube into the œsophagus and feed the patient in this way. The mouth should be kept as clean as possible by mild antiseptic mouth-washes of borax. The patient, if old enough, is cautioned not to speak or attempt to speak. The late after-treatment consists of a prolonged and diligent effort on the part of the patient, assisted by instruction, to correct the cleft-palate speech. Much can be accomplished by intelligent and persistent training in this direction, but still the peculiarity of speech is seldom fully overcome.

The use of *artificial obturators* instead of operative procedures has much to recommend it. Work of this kind is largely in the hands of dental surgeons, who are more competent than the general surgeon to make and apply the rubber plates required. Acquired defects of either the hard or the soft palate can be corrected in the same way as congenital ones. The time to undertake such operations is of course after the pathological processes producing such defects have ceased to be active.

Syphilis is a common cause of palatal defects : in such cases operation should be delayed until some months after the disappearance of the last symptom of such disease, and after an active and prolonged course of iodides and mixed treatment. *Traumatism* is a rare cause of acquired palate defects, and in those cases the operative repair should be either immediate or after the complete wound healing, and all disappearance of wound infection has taken place. When acquired defects are too large to be closed by plastic operation, the artificial obturator should be employed. (*Vide* also Appendix to this chapter.)

Acute Inflammatory Processes in the Mouth.

Acute inflammatory processes include *catarrhal stomatitis, thrush, ulcerating stomatitis, noma*, and the involvement of the mucous membrane of the mouth in the acute infectious diseases, as measles, diphtheria, scarlet fever, small-pox, etc. ; these latter being discussed more properly in works on general medicine.

Fig. 141.

Destruction of cheek, the result of cancrum oris (A. McL. Tiffany, *Amer. Syst. of Dent.*, vol. iii.).

Stomatitis catarrhalis is a simple catarrhal condition resulting from irritation of the mucous membrane from mechanical, chemical, or mycotic causes. It presents the symptoms of a desquamating catarrhal condition.

Its TREATMENT should be the removal of the cause wherever possible, as, when the condition depends on decayed and neglected teeth, the removal or filling and cleansing of the teeth and the use of some simple and non-irritating antiseptic wash, such as boric acid.

Stomatitis ulcerosa may follow simple catarrhal stomatitis or thrush, or may follow a severe and protracted illness or the lowering of the vitality of the tissues of the mouth from poisoning by mercury, phosphorus, lead, and copper. The character of stomatitis ulcerosa will differ with its cause. Its TREATMENT will be the removal of the cause wherever possible ; general and local treatment for the condition are at times required, the general being directed to the improvement of the resisting powers of the individual, and the local, such as application of

silver nitrate in stick or in strong solution to the ulcers, and the use of mild antiseptic mouth-washes.

Noma is a peculiar mycotic gangrene of the tissue of the cheek and jaws occurring in illy-nourished children, living, as a rule, under bad hygienic conditions, and usually during or after an attack of one of the infectious fevers. The probable PATHOLOGY of the condition is that it is not a disease produced by a specific microbe, but that a greatly lowered vitality, such as follows the infectious fevers in children living under extremely bad hygienic conditions, may enable the normal microbe inhabitants of the mouth to invade the tissues of the cheek and jaws, and produce a rapidly-spreading gangrene, and later general septic infection.

The disease is rare in America. The DIAGNOSIS does not present difficulties when the disease is well established: an early diagnosis is desirable, and should be followed by energetic local treatment, the destruction of the invaded tissue with nitric acid or actual cautery, and the use of continuous mild antiseptic dressings and washes; general treatment should be directed to the support and stimulation of the little patient by properly selected food and alcoholic stimulants. The PROGNOSIS is grave; the great majority of the patients die. Those who survive present the disfigurations due to loss of tissue and the resulting cicatricial contractions. Extensive plastic operations are required for correcting deformities resulting from noma—flaps being taken from the face or neck and turned into the defect in the cheek, the raw surface from which the flap is taken being closed by sutures or covered by skin-grafts. (*Vide* Vol. I. Chapter V.)

Cracks and fissures of the lips are common, and are usually trivial. They may, however, persist for some time, and give rise to much discomfort and demand surgical interference. Usually, touching the surface with nitrate of silver will be followed by wound healing and cure. It may in rare cases be necessary to dissect out the fissure or crack and unite the incision by sutures. At times the question of diagnosis between the long-persisting fissure and epithelioma may present itself. Such question is to be settled early by removing the tissues around the fissure and submitting them to microscopical examination. **Syphilis**, both primary and secondary, occurs on the lip; the former is more common in women than in men. **Tuberculosis** and actinomycosis of the lips occur, but are not common.

Epithelioma of the lower lip is a very common surgical lesion; the upper is seldom involved. It occurs with much greater frequency in men than in women. This difference is attributed largely to the use of tobacco. A good deal of evidence seems to support this theory, as tobacco is one of the chronic irritants, like soot and paraffin, that seem to play some part in the production or localization of carcinoma. The picture of epithelioma of the lower lip is so typical that when the student has seen several cases the condition is readily recognized. The age of the patient is of value; the presence of induration, scab-formation, ulceration, the length of time the lesion has existed, all aid in the diagnosis. Primary syphilis might be mistaken for carcinoma. Wherever a question exists as to diagnosis, resort to the microscope should be made.

The TREATMENT is that of carcinoma elsewhere—removal of neoplasm and adjacent tissue widely, and where there is evidence of lymphatic-node involvement these structures should be as widely as

possible removed. In epithelioma of the lower lip the submaxillary and sublingual salivary glands are often involved, and when involved should be removed.

The PROGNOSIS of carcinoma of the lip is that of carcinoma elsewhere. When the lesion is limited to the tissues first involved, and

FIG. 142.
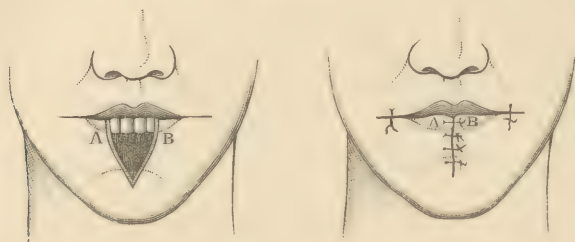
Cheiloplastic operation on lower lip (Tillmanns).

there is no regional or general infection, it is possible to obtain a permanent cure by complete removal of the diseased tissue ; but whenever the nearest group of lymphatic nodes are involved, even microscopically, recurrence after removal, or rather a continuation of growth of the carcinoma cells remaining, goes on unchecked by the operation.

There has been a persistent effort made within the last few years by surgeons in various specialties to improve the prognosis in carcinoma, and this has led to the publication of conflicting statistics, some surgeons claiming as high as 25 or 30 per cent. of permanent cures, or rather cases which have had no recurrence for three years after the operation. Most of these very favorable statistics are the result of juggling, the reporters being dishonest, at least with themselves. Permanent cure after operation for carcinoma is not common, and such cures at present, at least, form but a small percentage of our cases, probably 10 per cent., and are to be looked for, not in the extensive operations demanding wide removal and removal of adjoining lymphatics, but in the early simple cases where a V-shaped incision of the lower lip will remove all the carcinomatous tissue (Fig. 142).

Benign tumors of the lower lip include nævi, cysts, dermoid and labial-gland cysts, and papillomatous and horny growths.

Wounds of the lip are not rare. The tissue has high vitality and repairs itself readily. Accurate approximation should be obtained and efforts at antisepsis carried out.

Macrocheilia is a condition where the lips are so thick as to present a deformity. The condition is sometimes extreme, and demands surgical interference and operation of removing a V-shaped mass as in excision of carcinoma, or an elliptical-shaped section of mucous membrane when the lips are much everted.

THE TONGUE.

The tongue is the essential organ of taste. It also assists in the functions of speech, mastication, and deglutition. It is composed of a number of muscles, extrinsic and intrinsic, and covered in part by mucous membrane of a peculiar character provided with papillæ, circumvallate, fungiform, and filiform, and supplied with the terminal organs of taste, the taste-bulbs. By means of the extrinsic muscles the tongue is attached to the lower jaw, the hyoid bone, the styloid pro-

cess, and the soft palate. A median raphè of fibrous tissue divides the tongue into two halves. The raphè is comparatively non-vascular, and is a line in which incision can be made with little hemorrhage. The tongue is held forward in the mouth by the attachment of the mylo-hyoid, genio-hyoid, and hyoglossus muscles. When these muscles are divided in an operation, it may fall backward against the epiglottis and close the opening of the respiratory tract and produce suffocation. The *nerve-supply* of the tongue is derived from four nerves—the chorda tympani to the lingualis muscle, the hypoglossal nerve to the remainder of the muscles. The lingual branch of the fifth is the nerve of common sensation, and the glosso-pharyngeal the special nerve of taste. The *arterial supply* is derived from the lingual, facial, and ascending pharyngeal. The *lymphatics* drain into one or several nodes in the submaxillary region between the hyoid bone and tip of the chin, and into the deep lymphatic nodes of the neck.

The tongue is developed in the fœtus from the floor of the pharynx, and appears at first in three parts, a central and two lateral portions. The first is derived from the tissues between the first and second branchial arches in the mid-line. Immediately behind this the central portion of the thyroid is developed from a bud of hypoblastic tissue. The point from which this bud springs remains as the foramen cæcum and as an abnormality. A duct may persist from the foramen cæcum to the thyroid isthmus, called the thyroglossal duct. The lateral halves of the tongue are derived from the second and third branchial arches ; the central part of the tongue is represented in the adult by the anterior portion, including the V-shaped line of the circumvallate papillæ.

Congenital malformations of the tongue present themselves most commonly as a very much shortened *frænum, tongue-tie,* or a growing together of the floor of the mouth and under surface of the tongue. The condition of tongue-tie seldom needs surgical interference, although the frænum is often divided unnecessarily by physicians in children who are backward in learning to talk. Sometimes, however, the frænum is so short as to interfere with the functions of the tongue and demands division. The operation is a simple one, and consists of division of the frænum with curved scissors, care being taken to avoid injury to the ranine arteries, which run parallel to the frænum on either side, covered simply by the mucous membrane. Another malformation is a very long frænum, permitting the tongue to fall backward against the epiglottis. Cases of suffocation in children have been reported from this cause. A rare malformation is that of bifid tongue. An abnormally large or long tongue or abnormally small tongue, or even total absence of the tongue, occurs as a congenital defect.

Injuries of the tongue may result from mechanical, chemical, or thermic causes.

The *mechanical* injuries present themselves as incised, lacerated, and penetrating wounds. Lacerated wounds occur often from biting the tongue in epileptic attacks—from falls upon the face with some foreign body, as a pipe, in the mouth. Wounds of the tongue may be serious from division of some large arterial branch, and may require ligation of the vessels at the site of injury, or ligation of the lingual artery at the point of election immediately above the hyoid bone. Extensive wounds of the tongue should be handled as wounds elsewhere : the hemorrhage should be controlled, the tissue made as aseptic as possible, and the edges accurately united with catgut stitches.

The *after-treatment* should consist of mild antiseptic mouth-washes. The fact that local infection may extend to the tissue of the floor of the mouth, and even to the pharynx and larynx, the latter sometimes resulting in œdema of the larynx and demanding tracheotomy, should be borne in mind.

Chemical injuries of the tongue may result from the drinking of acids and alkalies. The TREATMENT required has been outlined in similar injuries of the mucous membrane of the mouth. Burns result from the accidental drinking of very hot liquids; as a rule, they are not severe and require as treatment a mild antiseptic mouth-wash.

Acute inflammatory lesions include acute inflammation of the mucous membrane and acute inflammation of the deeper tissues of the tongue and the floor of the mouth. Acute inflammations of the mucous membrane are usually coexistent with stomatitis, and due to the same causes and require the same treatment.

Acute inflammation of the deeper tissues of the tongue, *acute paren-chymatous glossitis*, may result from injury or be secondary to some lesion of the mucous membrane, or it may appear without the occurrence of a recognized injury. It may be limited to one side of the tongue. Usually, however, it involves both lateral halves.

The SYMPTOMS are those of swelling, sometimes extensive; pain and dryness of the surface; and constitutional symptoms varying in degree, but often marked; the inflammation may extend to the floor of the mouth and to the epiglottis and larynx; suppuration may result; when pus forms it should be early recognized and evacuated by free incision.

In making the incision care should be taken to avoid the large vessels, and if the pus-accumulation is deep, the best plan to pursue is that adopted by Hilton in deep cervical abscess—*i. e.* the division of the mucous membrane with the scalpel, and then bore into the deeper tissues with a closed artery-forceps until the pus-cavity is reached. The blades of the forceps are then opened and withdrawn in this position, making in this way free drainage with the least possible danger to the vessels and nerves of the part.

When the inflammatory process has extended to the floor of the mouth it may result in the condition described by Ludwig, and known as **Ludwig's angina.** This condition may result from an *acute glossitis*, but is more commonly the result of *infection extending from the teeth or jaw*, or may make its appearance as a primary condition without any other known injury or pathological condition. It is an acute inflammatory affection of the tissues of the floor of the mouth, involving especially the fibrous tissue. It may or may not go on to suppuration; the dangers are general infection and œdema of larynx.

Early in these cases the TREATMENT should be hot aseptic poultices externally and antiseptic mouth-washes.

If the infiltration is extreme, free incision, both externally and internally, is required, after the Hilton method, and if pus-formation occurs free drainage in the same way. The danger of œdema of the larynx may usually in this way be avoided, but if urgent dyspnœa presents itself, a tracheotomy should be prepared for and not too long delayed. The œdema of the larynx may come on rapidly. The author has seen one case in which this condition came on and resulted fatally within a few hours after the first symptoms presented themselves.

Chronic injuries of the tongue require mention. These are commonly the result of irritation of ragged and diseased teeth. They present themselves as chronically inflamed points of cicatricial and granula-

tion tissue. They are cured usually by the removal of the cause; sometimes, however, they may form the starting-point of carcinoma. Considerable clinical evidence goes to support the statement that carcinoma of the tongue may result from chronic irritation and chronic injuries to its mucous membrane.

Granulomata of the tongue include *tuberculosis, syphilis,* and *actinomycosis.* Tuberculosis of the tongue as a primary affection is rare. It occurs usually in cases of general tuberculosis.

When primary the DIAGNOSIS is difficult, and the case may be mistaken for carcinoma or syphilis. Sometimes the bacilli of tuberculosis can be found in the scrapings of the ulcer, but this is not the rule. *Syphilis* can be eliminated by the use of large doses of iodide. The lesion appears, as a rule, as a chronic ulcer with mouse-gnawed edges and covered with a gray membrane. The question of diagnosis between carcinoma and tuberculosis is often difficult. The peculiar mouse-gnawed edges of the ulcer, the fact that the margins are not as indurated as in carcinoma, the presence of small tubercles in the immediate vicinity of the lesion, and the removal of a small section and its histological examination will, as a rule, determine the diagnosis. In cases of advanced general tuberculosis, tongue-tuberculosis should receive palliative treatment, the occasional application of silver nitrate, the use of an antiseptic mouth-wash. In cases of primary tongue-tuberculosis very radical treatment should be employed—the removal of the entire lesion and the healthy tissues some distance beyond, either with knife or cautery.

The PROGNOSIS in such cases, not only for the cure of the local lesion, but the prevention of general infection, is good.

Caseating tubercular foci may appear in the tongue as in the mammary gland—may be single or multiple. Their TREATMENT, when simply an evidence of general tuberculosis, should be palliative or incision and removal of tubercular granulation-tissue with sharp spoon; when primary, wide and radical removal.

Syphilis of the tongue is common. It may present itself in several forms, either the primary lesion of syphilis or the mucous patches of secondary syphilis or gumma, which may break down and form a deep syphilitic ulcer; or, lastly, syphilitic warts of the tongue.

The primary lesion of syphilis is not common; it is not often diagnosed early because of its occurrence in such an unusual locality. It presents the characteristics of hard chancre, usually single, indurated base, sloping edges, slight discharge, resulting adenitis. In questionable cases TREATMENT should be delayed until the diagnosis is made certain by the appearance of secondary symptoms. The other forms of syphilis are, as a rule, readily recognized, and should be submitted to antisyphilitic treatment of iodide of potash and mercury, and local treatment of silver nitrate and antiseptics; best, boric-acid mouth-washes. *Syphilitic condylomata* can be removed, but the general and local treatment as outlined above should be instituted.

Actinomycosis of the tongue is a rare lesion. The condition may present itself as a hard mass of granulation tissue, or later, after softening, as an ulcer or cold abscess.

The DIAGNOSIS must depend on the discovery of the actinomyces from the gross appearance of the pus or by the microscope.

The TREATMENT is the removal of the granuloma with sharp spoon,

knife, or cautery, and the internal administration of iodide of potash, which from recent clinical evidence seems to have a curative effect.

The PROGNOSIS, when the lesion is not extensive, is favorable under such treatment. (See Vol. I. Chapter VIII.)

The **benign tumors of the tongue** include *nævi*, which are common, *dermoid, lipoma, papilloma, fibroma,* and *enchondroma*. In this connection we may well discuss the matter of *retention-cysts* of the small mucous glands about the tongue and the rather confused subject of *ranula*. *Nævi* of the tongue may be divided into arterial, venous, or capillary according to the preponderance of one or the other systems of blood-vessels involved. They are, as a rule, congenital, and often present themselves as very small tumors at birth, which may grow rapidly and involve a large portion of the tongue, and even extend beyond the limits of that organ. They are to be treated as nævi elsewhere—when possible by clean excision; when not, ligation or the use of galvano-cautery needles.

A condition somewhat resembling nævi is the condition of **macroglossia**, which is due to an hypertrophy of the lymph-vessels. Cases of macroglossia grow sometimes to great size. (See Vol. I. Chapter XXX.) They demand operative relief, excision of the redundant portion, and accurate flap-formation, and suture to manufacture a tongue of the tissue allowed to remain. The other forms of benign tumor, dermoid cysts, lipoma, enchondroma, fibroma, etc., are to be treated by removal.

FIG. 143.

Macroglossia (Tillmanns).

Retention-cysts of the tongue are common, those occurring in the floor of the mouth being grouped under the name ranula. The most common is a cyst formed by retention in the gland of Nuhn on the side of the frænum. Similar clinical pictures are presented by retention-cysts of the duct of Wharton or the ducts of Rivini.

The DIAGNOSIS is, as a rule, not difficult, but may be mistaken for a dermoid in the floor of the mouth. Usually the cyst-wall is thin, transparent, and the cyst filled with clear fluid.

The best TREATMENT is to dissect out the entire cyst-wall, which can, as a rule, be done. When this is not possible, a large section of the cyst-wall should be snipped out with scissors and the cavity packed with gauze, and a permanent opening obtained, or the cyst-wall remaining can be destroyed by the cautery. Dermoid cysts in the floor of the mouth, when small and superficial, should be dissected out by an intraoral operation; when large and deeply seated, an external dissection is to be preferred.

The tongue is often the seat of **primary epithelioma**. The lesion occurs much more frequently in men than in women, and, like carcinoma elsewhere, is a disease of advanced middle life and old age. It is probable that the use of tobacco is an etiological factor in the development of tongue-carcinoma: cicatricial tissue, the result of chronic lesions

and benign growths, such as papilloma, sometimes becomes the seat of carcinoma. The cancerous growth begins, as a rule, on the tip or sides of the tongue, and consists in the majority of cases of flat epithelial cells. It rarely begins in the epithelium of the glands of the tongue.

The DIAGNOSIS is made from the induration, the chronicity of the lesion, the age of the patient, and by the exclusion of the granulomatous lesions, of syphilis, tuberculosis, and actinomycosis. The disease may appear as a warty growth, an ulcer, or as a fissure. In all forms the characteristic hardness of carcinoma is present.

In advanced cases the diagnosis is easily made from the clinical picture. In lesions seen early it may be impossible from the clinical evidence above to make a diagnosis. In such cases syphilis should be excluded by antisyphilitic treatment, and the question of the pathology of the process established before radical operation by a removal of a part of the growth, and a careful histological examination. An early and accurate diagnosis is of the greatest importance. Every warty growth or persistent ulcer or fissure of the tongue, especially in individuals beyond forty, should be regarded with suspicion, and its benignant or malignant character determined by the most careful analysis of the case, resort being made to the removal and microscopical examination of the tissue where a positive diagnosis cannot be arrived at by other means. A primary carcinoma of the tongue is followed later by regional involvement of the submaxillary lymphatic nodes and cervical lymphatics—by the involvement of the surrounding structures, the submaxillary gland, the sublingual gland, the tissues at the floor of the mouth, the fauces, and even the inferior maxilla. In advanced cases the condition of the patient is most pitiable: severe pain, interference with speech, mastication, and deglutition, profound carcinomatous cachexia, gradual exhaustion, septic infection, hemorrhage, complete the clinical picture.

The PROGNOSIS is grave, both from the standpoint of possibility of cure and the life-expectancy of the individual. Cases live from one to two years after the beginning of the disease. Return after even early and radical operations is the rule; probably not 10 per cent. of cases of carcinoma of the tongue are alive and free from recurrence three years after radical operation.

The TREATMENT of carcinoma of the tongue is simply stated: early and radical removal in operable cases; the euthanasia of morphine and cleansing mouth-washes are advisable in the inoperable cases, with possibly the added resection of the lingual nerve to relieve the excruciating pain which is an almost constant accompaniment; and proximal ligation of the lingual artery to control hemorrhage and to retard the rapidity of the growth. The operative treatment involves either the partial or complete removal of the tongue and draining lymph-nodes. In small lesions removal of the involved area and the apparently normal tissue wide of the disease should be the treatment. In lesions distinctly limited to one side, all of that side should be removed. In advanced cases and cases involving both sides the operation of complete extirpation of the tongue and adjoining lymphatics should be carried out.

Partial excision of the tongue can be, and should be, made as an intraoral operation; a preliminary ligation of the lingual just above the hyoid bone can be made, but is usually not necessary. The mouth is thoroughly cleansed and made as aseptic as possible. The patient is anæsthetized; a mouth-gag is inserted between the teeth and widely opened; the tongue is drawn well out of the mouth with a stout silk suture passed through the tips or with volsellum forceps. If the lesion involves the tip, after division of the frænum a V-shaped segment, in-

cluding the carcinoma, is removed, the hemorrhage controlled by catgut ligatures, and the lines of incision approximated by sutures.

When the carcinoma is limited to one-half of the tongue, after division of the frænum the tongue is split into two halves with scissors through the comparatively non-vascular raphè. The diseased half is removed with scissors, the hemorrhage controlled with clamp-forceps, the larger vessels are ligated, and the parenchymatous oozing is controlled by the deeply applied sutures employed to approximate the mucous membrane. The same result may be obtained by removal with galvano-cautery wire or écraseur. Clean removal with scissors and careful ligation is to be preferred to either écraseur or cautery. Complete extirpation of the tongue should be made through the floor of the mouth as an external operation, after the method of Kocher, of Regnoli, or of Billroth.

Kocher's Operation.—An incision is made from the symphysis of the jaw downward in the median line to the body of the hyoid, then along the body and great cornu of the hyoid, and then from the tip of the great cornu to the mastoid process. This flap is dissected upward, the facial vein and artery ligated. The submaxillary gland is either turned upward with the flap or removed. All lymphatic nodes are extirpated. The mylo-hyoid muscle is separated from its attachment to the inferior maxilla, the mucous membrane of the mouth divided, and the tongue drawn out through the incision. The entire organ is then under direct control, and can be either completely or partially removed. If the entire tongue is to be removed, the lingual artery of the opposite side is ligated before the division of the lingual mass. A preliminary tracheotomy is desirable in cases of extensive involvement, but is not always necessary. After the introduction of the tracheotomy-tube the pharynx is tamponed with sponge or gauze to which a strong silk ligature is attached to facilitate its removal. The tongue can be removed either by cautery, écraseur, or scissors. The latter is to be preferred, great care being taken to ligate each bleeding point. The wound is packed with iodoform gauze; the tracheotomy-tube may be removed at once or allowed to remain a number of days. The patient is fed with a stomach-tube; the external wound is not closed, but allowed to heal by granulation. The dangers of the operation are hemorrhage, sepsis, and aspiration pneumonia. The mortality to be looked for in uncomplicated cases of extirpation of tongue is about 5 per cent. Kocher's own cases included a number of complicated cases which resulted in 20 deaths in 104 operations.

Fig. 144.

Lines of incision for total excision of the tongue (Chalot).

The operation of Kocher's is to be preferred to the other external operations of Regnoli, Billroth, v. Langenbeck, and Sédillot, which, however, are of sufficient interest and value to warrant a brief description.

The *Billroth operation* consists of a transverse incision below the symphysis, joined by two incisions, one on either side and parallel to the body of the jaw, extending to the great cornu of the hyoid bone. The skin and superficial fascia are first divided; then the mylo-hyoid, the genio-hyoid, and the genio-hyoglossus muscles are separated from their attachment to the lower jaw; the mucous mem-

brane at the floor of the mouth is divided, and the tongue drawn through the external incision and the extirpation proceeded with.

The *Regnoli operation,* of which Billroth's operation is a modification and improvement, consists of practically the same procedure by a different external incision. An excision is made in the middle line extending from the symphysis to the body of the hyoid bone. This is joined by two lateral incisions extending from the symphysis parallel with the lower jaw to the attachment of the masseter muscle.

The *operations of Sédillot and v. Langenbeck* involve the division of the lower jaw, an undesirable complication. Such a procedure may be required in extensive operative removal of the tongue and contiguous structures, such as the fauces and tonsil, but, as a rule, the same result can be accomplished by the Kocher operation.

The cases of carcinoma of the tongue and contiguous structures which come to the surgeon late in their history with extensive involvement, both regional and general, form a group which should be classed as inoperable cases and which should be carefully studied. The results of radical operations for tongue carcinoma are not sufficiently encouraging to warrant the surgeon in urging an operation in extensive cases of long standing, nor to hold out to the patient great hopes of a permanent cure. There can be no doubt but that many cases are operated upon where it is clearly impossible to remove all of the diseased tissue, and where it must be evident to the experienced surgeon that the cases have passed beyond the possibility of cure : we should recognize these cases as being

Fig. 145.
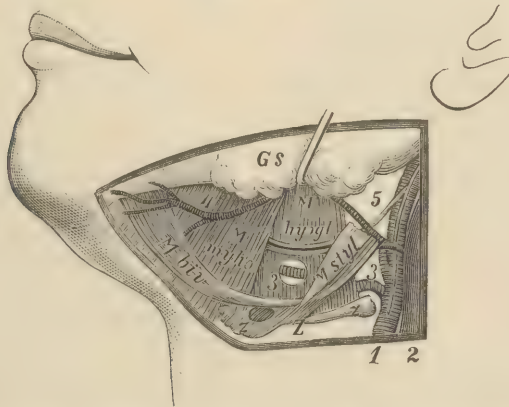
Exposure of base of tongue by incision along border of the jaw (Tillmanns).

inoperable, and discourage and refuse to perform any operation unless it be the palliative ligation of the lingual artery.

The TREATMENT here must be, as already stated, morphine in large and increasing doses ; deodorizing and aseptic mouth-washes ; attention to the general condition and comfort of the patient.

JAWS AND TEETH.

Each jaw presents an alveolar process which at birth contains the temporary and permanent teeth, the enamel portion of which is derived from the buccal epiblast, the remainder from the mesoblastic tissues of the mandibular and maxillary arches. After the loss of the teeth the alveolar processes are absorbed. The lower jaw contains the inferior dental canal, which has passing through it the inferior

dental nerve and vessels. The upper jaw contains the cavity of the antrum and the vessels and nerves of the upper teeth. The development of the teeth is of interest. Its careful study will explain such conditions as odontoma, abnormal position of teeth, the unusual occurrence of more than two sets of teeth, etc. The teeth consist of a crown of enamel, a body of dentine, and a coating of the dentine or the fang by a structure called cement. Between the body and crown is a constricted portion called the neck of the tooth. In the centre of the tooth is the pulp-cavity, filled by the pulp-tissue and communicating with the dental vessels and nerves through the small canal in the fang.

Congenital Malformations of the Jaws and Teeth.—The common malformation of the upper jaw called cleft palate has been discussed in connection with the surgery of the mouth; other rare malformations are arrest of development of one side of the upper or lower jaw or failure of union of the two halves of the lower jaw. Such conditions are not amenable to surgical treatment. *Malformations of the teeth* are common. They present themselves as excessive development of a tooth or a part of a tooth, either the enamel or the fang, or lack of development of a single tooth. An amalgamation of two or more teeth into a single mass; the development of a tooth in an abnormal position, as in the tissues of the hard palate; the projection of a tooth in an abnormal direction; the absence of a number of teeth—this condition may exist

Fig. 146.

Misplaced and imprisoned tooth (Forget),

as a total absence, edentulous jaws resulting; the presence of an excessive number of teeth, three sets of teeth having been often reported, but few of these cases are credited. The formation of a tooth-tumor, an *odontoma*, from the embryonic tooth-tissue is to be regarded as a congenital abnormality. Most of these malformations are treated by dental surgeons; the general surgeon, however, should be familiar with such conditions, because some of tooth-malformations present themselves as obscure conditions in patients applying for diagnosis and treatment. A tooth which has failed to erupt may lie as an encapsulated foreign body for years, and then become the focus for infection and abscess and resulting sinus, or, surrounded by granulation-tissue, may be mistaken for malignant growth.

Injuries of the Jaws and Teeth.—Fractures and dislocations of the jaws have been discussed in Volume I. under the general subject of Fractures and Dislocations. Injuries of the teeth, including fractures, the complete separation of the teeth from the alveolar process, and the subject of reimplanting such teeth, belong not to general, but to dental, surgery.

Diseases of the teeth and alveolar processes and gums include a discussion of dental caries, resulting pulpitis, infection of nerve-canals, and alveolar abscess.

The subject of **dental caries** has been much discussed, and many theories have been advanced to explain the condition. It was not until

the recent development of modern bacteriology had thrown light upon it that a rational explanation of dental caries was found.

The accepted view to-day is as follows: Many bacteria of the mouth have the power of producing lactic acid. Lactic acid dissolves out the inorganic elements of a tooth; it has little effect upon normal enamel, but acts rapidly upon dentine. A crack in the enamel and congenital defects in the enamel favor this process. After a decalcification has been brought about, the organic tissue remaining is readily destroyed by the saprophytic bacteria of the mouth. This destruction may extend to the pulp-cavity; as soon as the pulp-cavity is uncovered it becomes infected and sooner or later is destroyed. The infection may travel down a nerve-canal and infect the tissue of the alveolar process and gums, the periosteum, or the jaw itself. As a rule, the infection is limited, forming a small alveolar abscess or gum-boil, but the infection may be extensive and even result in general septicæmia, pyæmia, or death. A common result of alveolar abscess is a sinus leading from the root of the tooth through the alveolar process and opening on the mucous membrane.

The TREATMENT of dental caries is the removal of the carious structure and the filling of the cavity with gold, cement, or amalgam. This treatment is very satisfactory, and has been developed by American dentists to a high degree of technical perfection. When infection of the pulp-cavity has occurred, the tooth can be saved by a destruction of the pulp with arsenic or other chemical agents, the removal of the pulp, the thorough sterilization of the pulp-cavity and nerve-canal, and filling the cavity with gold or amalgam. It is, however, difficult to thoroughly disinfect the pulp-cavity and nerve-canal, and as a result many of the teeth in which the nerve has been killed have a small suppurating sinus leading from the root to the mucous membrane.

Alveolar abscesses, if small and superficial, usually open without assistance from the surgeon. When deeply seated they are exceedingly painful, the pain being produced by the retained inflammatory secretions. The pus burrows through the alveolar process; as soon as the diagnosis of alveolar abscess is made, the tooth, if worthless, should be extracted. This affords free drainage and immediate relief. If it is not desirable to extract the tooth, an early incision should be made and free drainage for the inflammatory products obtained. When a large alveolar abscess forms and points toward the integument, even though fluctuation can be clearly made out from external palpation, still the abscess should always be incised within the mouth-cavity in order to avoid the disfiguring and retracted scars which often result where the abscess opens on the face.

Gingivitis, or inflammation of the gums, may result from a number of causes, local and constitutional. **Pyorrhœa alveolaris,** mercurial gingivitis, scorbutic gingivitis, lead gingivitis, and phosphorus gingivitis are known. When the disease is due to purely local causes, as tartar on the teeth and uncleanliness, the cure can be brought about by the removal of the cause. When mercury is the cause, the treatment would demand a discontinuance of the drug, and locally mild antiseptic mouth-washes. In cases of

FIG. 147.
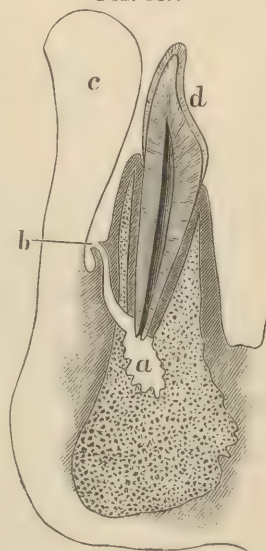
Chronic alveolar abscess at the root of a lower incisor: *a*, abscess-cavity in the bone; *b*, fistula discharging on the gum; *c*, lip; *d*, tooth (G. V. Black, M. D., *Amer. Syst. of Dent.*, vol. i.).

scurvy and lead-poisoning the cause should be removed and proper
general treatment and locally mild antiseptic washes should be advo-
cated.

Extraction of the teeth is to-day not considered a part of general
surgery, but a knowledge of a few general principles may prove of value.
The operation has been already described in Vol. I. Chapter XVIII.

Usually in these operations an anæsthetic is not required; gas is to be preferred
to chloroform or ether when general anæsthesia is necessary. Local anæsthesia
with cocaine is not to be employed, because the anæsthetic effect is not very marked,
and because of the danger of cocaine-poisoning and the possibility of infecting the
tissues by the introduction through the gum-tissue of the needle, which cannot
be effectually sterilized. The author has seen one case of death following local
anæsthesia from cocaine injections, the death being caused by infection and pyæ-
mia; and a number of serious cases of poisoning from cocaine itself are reported
from its use in teeth-extraction operations. The dangers of the operation are
slight, and yet jaw fractures and serious infection occur in a small percentage of
cases. The hemorrhage is, as a rule, trifling, but in cases of hæmophilia and
leukæmia it may be serious or even fatal. In cases of serious hemorrhage in these
conditions pressure is the best means of controlling the bleeding. In some cases
an aseptic gauze packing will control the hemorrhage; in others digital pressure,
with relays of assistants, may be required. The author has seen one case of hæmo-
philia in which it was necessary to keep up digital pressure almost continuously
for several days before the bleeding ceased.

The *after-treatment* of tooth extraction should be the use of a mild aseptic
mouth-wash. Unfortunately, this is often omitted. The importance of aseptic sur-
gery has been recognized rather later by dental surgeons than by the general surgeon,
and has not been as generally adopted. It is true that it is impossible to completely
sterilize the mouth-cavity, but the dangers of infection can be reduced materially
by vigorous attempts to make the field of operation clean with antiseptics.

Acute inflammatory processes of the jaws include *periostitis* and
osteomyelitis, and resulting *necrosis*. The most common cause of such
lesions is infection of the alveolar process from a carious tooth or from
fracture. Osteomyelitis of the jaws may occur as a primary condition
from infection from the circulation, as occurs in osteomyelitis of the
tibia, but this form is rare. Osteomyelitis sometimes follows the acute
infectious diseases, as scarlet fever, small-pox, typhoid fever, measles,
etc. (See Chapter XIV. Vol. I.) Other causes are mercurial poisoning
and phosphorus-poisoning. The alveolar process is alone involved, as a
rule, in pus-infection from a tooth caries; sometimes, however, the entire
thickness of the jaw may become involved.

The TREATMENT is free and early incision to afford drainage for the
inflammatory products, and later, if necrosis results, sequestrotomy.
The periosteum should be preserved when possible, for in the history of
these cases, even when the entire thickness of the jaw is removed, a
serviceable jaw is reproduced from the periosteum remaining.

Necrosis from mercurial and phosphorus-poisoning is now, fortunately, rare,
because of the smaller doses and less frequent use of mercury as a drug, and because
the improved methods of manufacturing matches, at least in America, protects the
employés better from the phosphorus fumes, and the weekly examinations of the
mouths of match-workers now in vogue in American match-factories reveals the
condition in its incipiency, so that the patient is saved from serious phosphorism,
either by being compelled to give up his employment or by proper hygiene of his
mouth. The PATHOLOGY of phosphorus-necrosis is of interest. Chronic phos-
phorus-poisoning produces an ossificating periostitis; small osteophytes form in the
periosteum of the alveolar process. This condition so lowers the vitality of the
jaw-tissues, gums, periosteum, and bone that the normal bacteria of the mouth
can invade the tissue and produce infection.

Dr. S. D. Stewart of Akron, Ohio, a dental surgeon of large experience in handling the employés of a match-factory where for a number of years he has made weekly examinations of the mouths of the employés, states that phosphorus-poisoning does not occur in individuals with good teeth who keep them clean with the daily use of a tooth-brush; further, that the removal of decayed teeth or the filling of cavities, the removal of tartar, and perfect cleanliness, even in individuals who enter the employment of match-making with unhealthy mouths, will practically ensure immunity against phosphorus-necrosis.

Empyema of the Antrum.—As a secondary lesion resulting from inflammatory lesions of the teeth and bone structure of the upper jaw we find *empyema of the antrum of Highmore*. This condition may also be secondary to inflammatory lesions in the nasal cavity.

The SYMPTOMS of empyema of the antrum are pain and swelling, discharge of pus, either through a fistula in the mouth or into the nasal cavity, where an exit for pus is present. When there is no exit the accumulation may distend the thin wall of the antrum and appear as a prominence in the mouth or on the face, or, by pushing up the floor of the orbit, produce a protrusion of the globe of the eye.

When empyema of the antrum is due to diseased teeth or bone structure, these causes should be removed; free drainage should be obtained, either through the mouth or nasal cavity. Where a diseased upper molar is the cause, after removal of the tooth a free opening may be found leading from the root-socket into the antrum, or, if a free opening does not exist, with a perforator the antrum may be opened and drained with a silver or rubber tube. The drainage may be made in the thin wall of the antrum just above the alveolar process, the thin bone being readily perforated at this point, or we may employ the method of Mikulicz of boring through the external wall of the nasal cavity below the inferior turbinated and making a permanent free opening between the nasal cavity and antrum. Park urges free opening into the antrum through its external thin wall, made from the mouth, so as to permit of digital exploration of its entire cavity.

Syphilis, tuberculosis, and *actinomycosis* are the common *granulomata* affecting the jaws. Syphilis presents itself as a late secondary lesion in the form of syphilitic necrosis and caries, involving more commonly the upper jaw, especially the hard palate.

The DIAGNOSIS is usually made from the history of the case, but here, as elsewhere, there may be an absence of history or the patient may deny having had syphilis.

Energetic mixed TREATMENT, and especially iodide of potash in large and increasing doses, two to three hundred grains a day, if necessary, should be employed; sequestra should be removed by operation. The treatment is, as a rule, highly satisfactory. The author has repeatedly seen cases of syphilis of the jaws yield to large doses of iodide when small doses, 10–20 grains, have been given without apparent effect.

Tuberculosis of the jaws is not common. It may be an accompaniment of general tuberculosis. When primary the local focus should be radically removed.

The jaw is a favorite seat of that rare lesion *actinomycosis*, or at least, if not the bone itself, the soft parts in contact with the bone are involved. Its common occurrence at this point in cattle has given to the disease its popular name of lumpy jaw. (See Vol. I. Chapter IX.) The disease may be mistaken for sarcoma. When pus exists it sometimes contains the small yellow bodies characteristic of actinomycotic pus. The DIAGNOSIS is settled by a histological examination of the tissue. The TREATMENT is removal of the granulation-tissue and the internal use of iodide of potash.

Diseases of the inferior maxillary articulation of surgical interest

are especially those conditions followed by partial or complete ankylosis of the joint. These are acute conditions, such as acute arthritis following injury, infectious diseases, as typhoid fever, small-pox, etc., acute rheumatism, gonorrhœal rheumatism, etc., or inflammation extending from the teeth or jaws to the joints. The author has seen two cases of pseudo-ankylosis result from the irritation of the eruption of a wisdom tooth. Chronic lesions also, as arthritis deformans and tuberculosis, and lastly cicatricial contractions following burns, noma, and injuries, result later in ankylosis. The condition of complete ankylosis is one very difficult to rectify. In cases of pseudo-ankylosis, opening the jaws under anæsthesia, and later the daily use of a mouth-gag to pry the jaws apart either by the patient or the surgeon, may bring about a cure. *In cases of complete ankylosis a false joint must be made* by an excision of the condyloid and, when necessary, coronoid processes. When complete ankylosis is complicated with extensive cicatricial contraction of the soft tissues, an extensive plastic operation is required. The results after operation for complete ankylosis are not, as a rule, satisfactory.

A peculiar condition of relaxation of the temporo-maxillary ligaments is occasionally met with, which permits of frequent *subluxation* of the joint. This occurs with a snapping sound usually during eating—is unnoticed by the patient himself, but not by others. It is painless, harmless, and not amenable to treatment.

Tumors of the jaws include *osteoma, odontoma, fibroma, chondroma, sarcoma, carcinoma, mixed tumors,* as fibro-myxoma, and *cysts.* The vague term **epulis** given to tumors springing from the alveolar processes, and usually fibroma or sarcoma, has nothing of value to warrant its retention in a scientific classification of jaw tumors, and should be discarded.

The differential DIAGNOSIS between these various tumors must be made from the clinical history and clinical evidence, and when this is not sufficiently clear on the histological examination of a portion of the tissue, the important point to determine is the benign or malignant character of the growth, as upon this must be based the character of the operation employed for the removal of the tumor. One form of tumor of special interest and of rare occurrence is the *odontoma* or tooth-tumor. These tumors are the product of abnormal development of a tooth-bud; they may consist of all the structures of the tooth, as enamel, cement, and dentine, or may involve but one of these to almost the exclusion of the other elements. (*Vide* Vol. I. Chapter XXVI.) These tumors are benign and demand simply the removal of the tumor-mass. Great care should therefore be taken not to mistake them for malignant growths and remove unnecessarily a large section of the jaw. *Cysts of the jaw* due to cystic tumor-formation from a tooth-follicle are called *dentigerous cysts:* they may grow to a large size and demand the removal or destruction of the entire cyst-wall.

RESECTION OF THE JAWS.

Resection of the lower jaw may be demanded for necrosis, for granulomata, as tuberculosis and actinomycosis, and for tumors. The excision

may be *partial* or *complete*—may demand the removal of one lateral half of the jaw or of the horseshoe-shaped body. The technique of removing one half of the lower jaw is as follows: An incision is begun at the symphysis a little below the bone and carried along the lower border of the body to the angle, then upward along the posterior border of the ramus to the condyloid process. The facial artery and vein are ligated and divided in front of the masseter muscle. The attachments of the masseter are divided; the periosteum at the line of the symphysis is divided vertically and the jaw divided in the same line with a saw. The attachments of the mylo-hyoid and genio-hyoid and genio-hyoglossus muscles to the inner surface of the jaw are separated, care being taken to control the hemorrhage as the operation proceeds. The attachment of the mucous membrane of the mouth to the gums is divided. The attachment of the external and internal pterygoid muscles, the division of the inferior dental nerve and vessels, the division of the temporal and buccinator, allow of a free exposure of the temporo-maxillary joints, the division of the ligaments, and the removal of the bone. Great care should be taken in working at the upper angle of the wound not to injure the facial nerve, the internal maxillary artery, and Stenson's duct. In resection of a portion of the lower jaw for necrosis care should be taken to preserve the periosteum. In resections for neoplasms this is not, as a rule, possible.

Resection of the upper jaw is a more formidable operation. The hemorrhage is, as a rule, great, and in cases of complete resection and in extensive resections for tumors it is often advisable to make a pre-

FIG. 148.
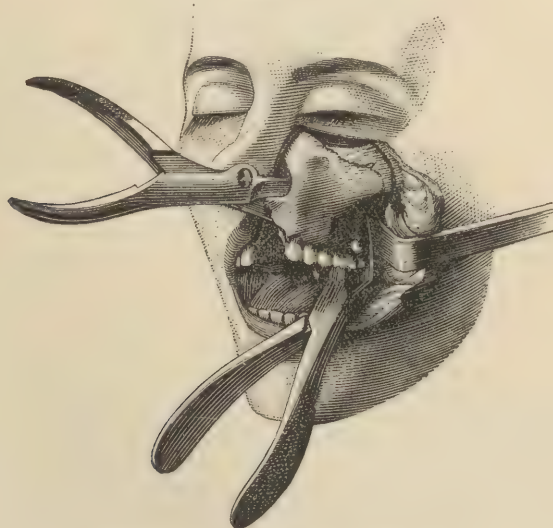
Resection of superior maxilla (Farabeuf).

liminary tracheotomy, tampon the pharynx, and continue the anæsthetic through the tracheotomy-tube in order to prevent the blood flowing back into the larynx.

The operation can be done in the hanging-head position or in the sitting position under mixed partial anæsthesia. In extensive operations preliminary tracheotomy and operation under complete anæsthesia is to be preferred.

A great number of incisions have been devised for the operation of resection of the upper jaw. The operation know as the Fergusson operation is, as a rule, to be preferred. (See Fig. 148.) The upper lip is split in the middle; the excision is then continued along the margin of the anterior nares, the wing of the nose, the lateral margin of the nose to beneath the inner angle of the eye, then along the lower margin of the orbit to its lower and external angle; this excision extends to the periosteum; the flap is dissected up from the bone and reflected downward

Fig. 149.
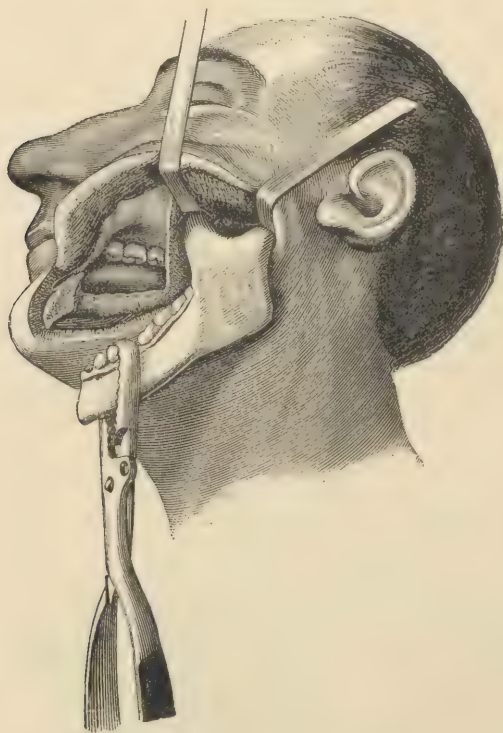
Resection of inferior maxilla (Farabeuf).

and outward; all hemorrhage is checked. The superior maxilla is then separated from the other bones of the face, a chain saw or keyhole saw or a large pair of bone-forceps or chisel may be employed. The malar, which is composed of compact tissue, is best divided with a saw; the palate process can be divided with large bone-forceps; the nasal process of the superior maxilla can be divided with forceps or chisel; the orbital process with chisel or bone-forceps; the attachments of the bone behind to the palate bone and the attachment of the palate to the pterygoid process of the sphenoid are best separated by grasping the mass of bone after the separation above referred to has been completed in a large pair of bone-holding forceps and twisting out the entire mass. The hemorrhage is free, and should be controlled by pressure, forceps, and ligature. Great care should be taken to ligate every bleeding point. The wound is packed with iodoform gauze and external incision closed. The dangers of the operation are sepsis and hemor-

rhage and aspiration pneumonia. Many other methods of making the external incision have been employed : such as those of Velpeau and Langenbeck, but the operation of Fergusson is to be preferred.

Partial resections are more often required than complete resections ; removal of the alveolar process can be completed as an intraoral operation by removal of the teeth, exposing the alveolar process with knife and periosteotom, and removal of the alveolar process with chisel or bone-forceps. Temporary resection is sometimes performed as an initial step in removing the second division of the fifth nerve or in the removal of a naso-pharyngeal tumor.

In making an osteoplastic resection of the upper jaw the operation of Langenbeck is to be preferred. A tongue-shaped flap of the soft parts and the bone between the hard palate and the floor of the orbit is raised and turned inward, the soft parts being allowed to remain attached to the bone after the operation, for which the preliminary osteoplastic operation is made, has been completed, the flap of bone and soft tissues is replaced and held in position by deep and skin sutures.

APPENDIX.

EARLY OPERATIONS FOR THE CLOSURE OF CLEFT PALATE.

By Truman W. Brophy, M. D., D. D. S.

Operations for the closure of cleft palate should be performed in early infancy. In making this statement I fully realize that my views are not in accord with those of many distinguished surgeons, but clinical experience has demonstrated that what I presented to the profession a few years ago as a theory in regard to palate operations has become a well-established practice. It is well known that many infants which are born with this defect die within a short time after birth when the cleft is of a marked character. Tait says that one-half of the children born with extensive clefts die from starvation within a few days after birth.

In this complication of hare-lip with cleft palate the practice has almost invariably been to operate upon the lip, and allow the fissure of the palate to remain unclosed. This, in my opinion, is a mistake. The palate should be first operated upon, for various reasons :

1. The fissure of the lip enables the operator to gain a little more room in which to work.

2. The closure of the palate is an operation attended with great difficulties in its performance ; besides, the closure of the cleft through the alveolar process, if it exists, may be more surely accomplished when fully exposed to view through the divided lip than when covered as it would be subsequent to the closure of the lip.

It is unnecessary to say that the bones are soft and will easily yield in early infancy. The tissues unite kindly, and the shock following the operation is not so great if performed within the first month as it would be later in childhood. It is a well-known fact that the nervous system of a child is not so well developed in early infancy as it is later; hence one of the advantages of performing this operation before the nervous system has developed to a point which would subject the child to a more severe shock. The operation, therefore, should be performed as

soon as the functions of the organs of the body are well established. This may be within the first week or any time within the first month.

3. After the operation the child will be better nourished.

4. If performed in early infancy the muscles of the palate will be brought into action and will be developed, whereas if the muscles are not thus put into use they will atrophy, and later it will be found, as is often the case, that there is insufficient tissue to restore the palate to its normal form. It is scarcely necessary to state that muscular tissue which is not subject to action and use will not develop normally.

5. One of the most important reasons why we should operate in early infancy is, that the parts operated upon early not only develop well, but the child when arriving at the age when articulation in the form of speech is attempted finds that he can speak as other children do, and does not acquire the habit of articulating through the nasal passage, which is characteristic of this deformity, for the nasal accent when once acquired cannot be easily corrected. Fissures or clefts of the palate are almost invariably accompanied with pharyngitis.

6. Before the calcification of the bone is far advanced, and also before eruption of the teeth, the operation on the hard palate can be more easily and successfully accomplished; if made subsequent to the eruption of the teeth, it is always attended with more difficulty and the results are less satisfactory.

The operation is as follows: Introduce the oral speculum and vivify the edges of the fissure; do it thoroughly. A mere scraping of the mucous membrane will never suffice to bring about union which will be permanent and satisfactory. On the hard palate trim well the opposing surfaces of the bone. If this be well done, it will secure a sufficient exudate to make the operation a successful one in this respect. The knife will easily cut through the soft bone of the hard palate and the alveolar process of young patients. Then raise the cheek, and well back toward the posterior extremity of the hard palate, just back of the malar process, and high enough to escape all danger of not being above the palatal plate of the bone, insert a large braided silk suture, carrying it through the substance of the bone, so that it will come out at a corresponding position upon the opposite side. It is often difficult to pass the suture through to the opposite side, and under such circumstances the needle, with eye in point, may be carried from the buccal surface of the bone to the median line, the stitch taken up with a tenaculum, and then the needle inserted from the opposite side, the thread then to be united and carried through. The silk suture is more easily introduced by the needle, but a wire suture of silver should be substituted for it and drawn through in its place, and this wire may be doubled in case the condition of the parts and the tension upon the tissues necessary to approximate them seem to require it.

Nearer the front portion of the palate insert another wire, carrying it through the substance of the bone above the palatal plates, and out through the other side in a position corresponding to the place of entrance. Thus we shall have one wire passing over the palate in front of the malar process of the bone and another behind it.

The next step is to take a lead button, moulded to fit the convexity

of the part, and long enough to pass beyond the exit of the wire sutures, so that they will pass through it. Have it provided with eye-holes, through which are passed the protruded ends of the wires upon each side, and then twisted. These are heavy tension sutures, and once approximated the parts cannot be separated by the patient. If we are unable to close the fissure with these wires, if from lack of tissue or from firm resistance of the parts it cannot be done, there is a further method to be employed which will obviate these difficulties. After the cheek is well raised divide the mucous membrane just over the malar process. Here insert a knife in a horizontal direction, and when well inserted sweep the handle around from one side to the other, as from behind forward. In this way a maximum amount of bone is divided

Fig. 150.
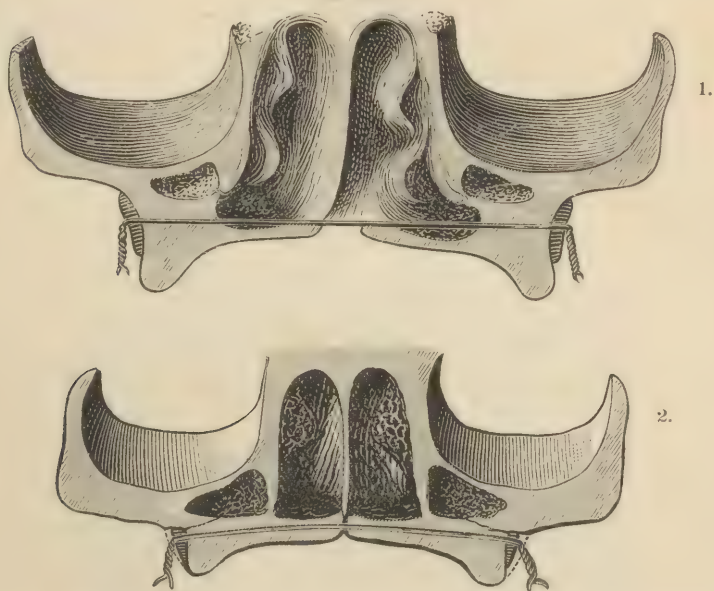
Manner of placing sutures.   No. 2 shows gain in closing defect after cutting malar process.

and a minimum amount of the mucous membrane. This done on each side, the bone can very readily be moved toward the middle line. Having thus divided the bones upon either side, the wire sutures passing through the lead buttons may again be twisted, and the cleft of the hard palate will be easily closed by approximation of the two sides.

The incision in the mucous membrane in making the separation of the bones should be as small as possible, for the reason that this membrane must serve to retain the bones in proximity or to hold them nearly together. If, after the parts are approximated, they are kept antiseptically clean, the bones will kindly unite and the palate will be restored, so that its full function will be performed. Separation of the bones is attended with little hemorrhage, and the parts do not usually cause more inconvenience to the patient than the ordinary operation of lifting the hard palate according to the practice of Fergusson.

The germs of the teeth are sometimes disturbed, as I have found later, when they were erupted, that certain teeth were imperfectly

formed. This applies to the molars of the temporary set, but the germs of the permanent teeth may also be disturbed, and the teeth made imperfect by this procedure; but the dental defects are of little importance when offset by the benefits of being relieved of so great a deformity. The palate, too, may be contracted to an abnormal extent; and yet it is a well-known fact that the alveolar process develops with the eruption of the teeth, and my experience has convinced me that in mouths thus treated the upper teeth when they erupt opposed in a normal way those of the lower jaw. If, however, the superior arch should be abnormally contracted, the means well known to the modern dentist may be employed to widen it.

After the approximation of the edges in the manner I have described the parts should be thoroughly dried, the edges of the wound carefully examined, and if need be some fine sutures inserted here and there to ensure perfect coaptation of the parts. The *after-treatment* is very simple, consisting solely in antiseptic cleanliness, nourishing of the patient upon liquid food, the prevention of disturbance of the parts by the child, or of the introduction into the mouth of anything that might interfere with the sutures. Abrasions of the mucous membrane caused by the buttons need not disturb the operator, for they are usually slight.

A New Method of Closing the Soft Palate.

The difficulties attending the closure of the soft palate may be, to a very great extent, overcome by making use of the method which I

Fig. 151.

Staphylorrhaphy: sutures in position.

here illustrate. Delicacy of the tissues and the tendency of the sutures to cut out suggested to me that a modification of the quill suture, long

ago introduced, would aid us materially in retaining the sutures and preventing their cutting out after performing the operation of staphylorrhaphy.

Inasmuch as lead is tolerated so well by the tissues, I have employed it for this purpose.

The first drawing (Fig. 151) will show cleft of the soft palate, the fissure extending through the palatal plates of the maxillary bones. After the edges of the cleft are well freshened, a properly formed needle, curved after the fashion of the gynecologist's needle, is employed with which to introduce silk sutures, four of which are carried through the tissues, as shown by the drawing, and these are substituted by rather strong silver sutures ; then the lead plates are perforated with

Fig. 152.
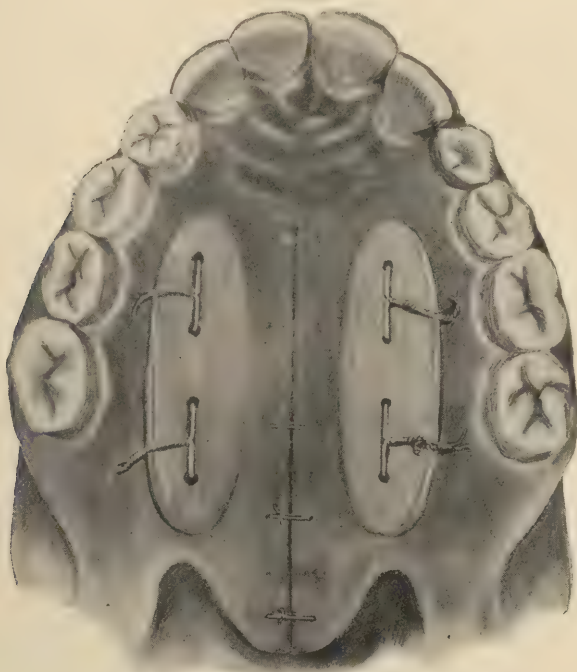
Staphylorrhaphy : sutures and lead plates in position.

holes corresponding to the number of four sutures, shaped so as to extend from the anterior margin of the fissure back to the distal border of the soft palate, and bent to conform to its shape. The wire sutures are then passed through the holes, as shown by the drawings, and twisted together. Tension is thereby exerted upon the divided portions of the palate and their edges are approximated. Should it become necessary, as is often the case, to divide the bones along the border of the hard palate nearest to the molar teeth, this may be done by the use of a strong scalpel or chisel, and then the lead plates are easily brought toward each other, together with the tissues that they embrace. In certain cases the elevation of the soft parts, together with the perios-

teum, may serve our purpose quite as well : this can be accomplished by means of a properly bow-shaped periosteotome. After the edges of the plate have been approximated by the twisting the wire sutures together, as shown by the drawing (Fig. 152), fine silk sutures may then be employed with which to hold the approximated edges in close contact and secure immediate union.

The *advantages* claimed for this method of procedure are—1. The prevention of the cutting out of the sutures, since the lead plates coming in contact with the soft palate exert pressure thereon, and the tension, therefore, is not made by the suture alone, which exerts pressure on so limited a space, but it is upon the entire length of the palate covered by the lead plates. 2. The lead plates serve as a splint, rendering the palate inflexible to a very great extent. The movements, which are almost constant, are suspended ; the active muscles are put out of use until union of the cleft may take place.

In conclusion, after using this method of closing the soft palate I feel confident that better results in a certain number of cases can be secured than by the employment of sutures alone. This is not to take the place of the operation of dividing the bones at the malar process and carrying the greater portion of the maxillary bones together, but it is adapted to the treatment of patients whose bones are well ossified and whose deciduous teeth are well erupted. It is in such cases that I recommend this operation.

CHAPTER VIII.

SURGERY OF THE ABDOMEN.

By Maurice H. Richardson, M. D., assisted by Farrar Cobb, M. D.

Injuries and Wounds of the Abdomen.

Contusions of the abdominal wall may cause hernia, hemorrhage, lacerations, and ruptures of muscles and aponeuroses. *Ventral hernia* from this cause is unusual. The inguinal, the femoral, or the umbilical rings may give way as the result of direct blows, though powerful reflex contractions of the abdominal wall are a more common cause of hernia. (See Hernia.)

Circumscribed hæmatomata and extravasations of blood between the layers of the abdominal muscles occur most frequently in the flanks, where they may attain great size. Extensive hemorrhage results in circumscribed or diffused hæmatomata which present characteristic signs.

Unaccompanied by sepsis, even the largest hæmatomata are rapidly absorbed, and require no treatment beyond rest and cooling applications. Increasing in size from persistent bleeding, they may require incision, ligation of vessels, or gauze-packing. When sepsis supervenes thorough drainage is demanded. If the serum of a hæmatoma is withdrawn by aspiration, excessive care is necessary to prevent infection.

Slight and incomplete ruptures of the muscular wall cause transitory pain and tenderness without physical signs; complete rupture will cause pain, tenderness, muscular weakness, and eventually hernia.

In extensive ruptures the DIAGNOSIS is sooner or later apparent from the depression which exists between the separated muscular structures.

The TREATMENT requires rest, with such external applications as will make the patient comfortable. The divided structures may be exposed and sutured immediately or after the subsidence of acute symptoms.

From blows without penetration the abdominal viscera are frequently the seat of more or less serious lesions. The *hollow viscera are liable to rupture with extravasation;* the *solid, to fracture with hemorrhage.* Lacerations of the *omentum* or of the mesentery cause, if anything, hemorrhage. After abdominal contusions the earliest possible recognition of extravasation or of hemorrhage is demanded. The exact seat, nature, and extent of the lesion can be determined only by surgical exploration.

Rupture of the hollow viscera, with extravasation, is marked, as a rule, by the symptoms of localized or of general peritonitis; rupture of other viscera, by the signs of hemorrhage. Intestinal extravasation after a blow is attended by pain, tenderness, vomiting, and distention; the abdominal muscles are rigid, the resonance tympanitic. When gas has

escaped freely into the peritoneal cavity, its presence between the upper surface of the liver and the diaphragm usually masks by tympanites the liver dulness. *The signs of extensive abdominal hemorrhage* are faintness, pallor, rapid and feeble pulse, restlessness, sweating, shallow respiration, thirst, and cold extremities. Large amounts of blood in the abdominal cavity will cause dulness in the flanks. In slight hemorrhages pain and faintness are transitory, though the shock is generally out of proportion to the amount of blood lost. A local tumor may exist, though it may not always be detected. Retroperitoneal hemorrhages may cause a prominence, with ill-defined resistance deep in the abdominal cavity.

Rupture of the Stomach.—Ruptures of the stomach, owing to the thickness of its walls and the tendency of the mucous membrane to evert, are not ordinarily followed by so rapid or so extensive a peritonitis as rupture of the intestine. In perforations of the posterior wall the infection, usually confined to the lesser omental cavity, results in *subphrenic abscess.* Perforations in the anterior wall, especially when the stomach is full, are more liable to be attended by extensive extravasation and general peritonitis. After a blow upon the epigastrium pain in that region, with vomiting, tenderness, and muscular rigidity, indicates rupture of the stomach. Hæmatemesis shows that the stomach is at least lacerated. The symptoms of subphrenic abscess following such a history are dependent upon rupture of the posterior wall.

The edges of the wound in rupture of the stomach should be carefully inverted and sutured. If the lesion is in the anterior wall, this is comparatively easy ; if in the posterior, difficult, sometimes even impossible. Extensive lacerations may require the infolding of large areas. In case satisfactory closure of wounds in either surface is impossible, gauze should be packed about the gastric opening and brought out of the abdominal incision. This method ensures rapid adhesion-formation and efficient drainage. Hemorrhage should be controlled by means of ligatures or of gauze tamponage.

Rupture of the Intestine.—When the intestinal wall is torn, the extravasation is usually so rapid as to produce immediately a general and fatal peritonitis, especially if the intestine is filled with gas and liquid fæces. When the intestinal contents are solid, as is generally the case below the ileo-cæcal valve, the extravasation may be slight and limited, and the patient often recovers spontaneously. When the perforation is small, eversion of the mucous membrane may limit the extravasation to a localized infection or even prevent it entirely.

DIAGNOSIS.—If the initial pain and tenderness are about or below the umbilicus, and the symptoms are rapidly progressive and gas is free in the abdominal cavity, it is more likely that the intestine rather than the stomach is the seat of rupture ; if in the epigastrium, with moderate peritonitis and early vomiting, especially if the vomitus contains blood, in the stomach rather than in the intestine. Extensive and rapid extravasations from either stomach or intestines, unaccompanied by hæmatemesis, can be differentiated only by the seat of the initial pain. At times a clear discrimination is impossible.

TREATMENT.—When intestinal rupture is suspected the incision should be made in the median line, either above or below the umbilicus according to the preponderance of symptoms. A region of extreme tenderness, an area of dulness, or a tumor may at times indicate the precise

line of incision. The escape of turbid serum, of gas, or of fecal matter the moment the peritoneum is opened proves the existence of some serious complication. The seat of the lesion can be found at times only by examining the whole intestinal tract. It is important, therefore, to have an incision sufficiently long to permit efficient examination. The distention usually present in these cases makes thorough inspection without complete evisceration at times impossible. Extensive exposure of the intestines, however, adds gravely to the shock. *Exploration* should therefore be made with as little exposure as possible, and as rapidly as is consistent with thoroughness. The intestinal wounds should be closed by inverting the peritoneal surfaces and suturing. Coils so extensively lacerated that suture is impossible must be *resected*, and either sutured or fastened into the abdominal wound for temporary relief. The peritoneal cavity must be carefully cleansed by irrigation and by drying with gauze after repair of the bowel. This step must be preliminary to the formation of an artificial anus.

Rupture of the healthy gall-bladder in some instances causes no symptoms beyond those of transitory pain and shock ; in others the contents of the inflamed and distended gall-bladder are sufficiently septic to cause a rapid general infection. In the former the lesion can be only suspected ; in the latter it may be evident. Peritonitis from this cause is seldom so fulminating as in ruptures of the intestinal canal. The pain is situated at first in the region of the gall-bladder ; later it becomes general.

When rupture of the gall-bladder is suspected, surgical exploration is demanded. The rent in the gall-bladder should if possible be sutured ; if this be impracticable, temporary drainage by means of a tube or of gauze may be used as in cholecystotomy. The extravasated bile should be removed as thoroughly as possible.

Rupture of the spleen, the pancreas, or the liver is usually attended by signs of hemorrhage, with pain referred to the seat of lesion. General peritonitis rarely complicates this accident : septic processes in these viscera are, as a rule, limited to abscess. For serious hemorrhage interference is demanded ; for slight, rest and palliative measures. In many cases in which the lesion is obscure and the symptoms trivial, treatment must be expectant. In ruptures of the spleen and of the liver the friability of these organs makes control of the hemorrhage by ligature or by suture difficult, if not impracticable. In hemorrhage from slight rents sutures of thread or of catgut may be passed under the lesion by means of a round curved needle. They should be tied tight enough to control the bleeding, but not tight enough to cut the tissues. In most cases, however, the hemorrhage can be successfully controlled only by closely packing the wound with gauze. Rupture of the spleen may require splenectomy. Hemorrhage from the pancreas may be arrested by ligature if the bleeding point can be found ; if not, by tamponage. In ruptures of the omentum and of the mesentery the chief symptom, hemorrhage, can be controlled by ligation. If a considerable portion of the mesentery is detached from the bowel, necrosis of the latter may follow and require resection.

The PROGNOSIS in ruptures of abdominal viscera is usually serious. Intestinal extravasations are generally rapidly fatal. Rupture of the

stomach results more favorably after interference than rupture of the intestines. Simple hemorrhages, extensive enough to produce serious exsanguination, are in themselves grave accidents. Hemorrhages of even moderate extent, complicated by septic extravasations, usually result in a fatal infection.

In retroperitoneal hemorrhage the source of the blood is obscured by the infiltration of the connective tissue. It is best not to make prolonged attempts to find the bleeding point, but to control by means of gauze tamponage. The loss of blood may be so moderate as to cause few if any symptoms, or it may be so extensive as threaten life.

In penetrating wounds of the abdomen, usually caused by gunshots or by stabs and cuts, the abdominal wall may be the seat of extensive hemorrhagic infiltration or the source of rapid external bleeding. The tendency of a completely divided artery is to contract and to curl up; when this occurs deep in the abdominal wall the arterial stream may be directed backward into the abdominal cavity, and the latter filled with blood before the truth is even suspected. Such an accident has happened after cutting the deep epigastric artery in the course of operations near the inguinal ring. The epigastric artery may be injured also by the use of cutting needles in sewing up abdominal wounds.

Prolapse, more or less complete, of the *omentum,* the *intestines, the stomach, the spleen, the pancreas, the liver, or even the kidney,* may take place through *incised wounds of the abdominal wall.* At times evisceration may be extensive. The omentum of all the abdominal viscera is most likely to escape. The accident occurs not infrequently from separation of an abdominal wound, caused by coughing, straining, etc. after or even before the removal of the sutures.

In the TREATMENT of wounds of the abdominal wall it is important first to discover and to check a *concealed hemorrhage.* The presence of an external hemorrhage is always conspicuous; its treatment obvious. The wound itself should be carefully cleansed and sutured if it is evident, on careful examination, that no injury has been done the abdominal viscera. Wounds clearly septic should be drained by means of a strand of gauze. Prolapsed viscera should be carefully cleansed, and if uninjured replaced. The wound may be sutured immediately unless sepsis is feared.

When the abdominal cavity has been penetrated the wound should be enlarged sufficiently to permit satisfactory demonstration of the condition of the intra-abdominal organs.

Gunshot wounds are more likely than stab wounds to lacerate the abdominal viscera, especially the intestine, and to tear arteries and veins. A cutting instrument in the majority of cases will pass between the intestinal coils and do no injury to them. It may even miss the blood-vessels of the omentum, the liver, or the spleen. Stabs unaccompanied by the signs of either extravasation or hemorrhage do not, therefore, demand exploration in every case, though it is undoubtedly the safest plan to investigate thoroughly all such injuries. On the other hand, a bullet passing through the abdomen can hardly fail to do serious injury to some viscus. Expectant treatment is therefore unjustifiable in gunshot wounds which penetrate the abdominal wall, whether the signs of hemorrhage and extravasation are present or not.

Stabs and incised wounds, homicidal, suicidal, or accidental, are produced by knives, swords, daggers, razors, glass, and other cutting substances. The external opening and the visceral cut may be small and punctured or large and incised. The internal lesion may be harmless, or it may cause hemorrhage or extravasation,

or both, manifested by characteristic symptoms already described under Visceral Rupture.

Incised wounds of the abdominal viscera may be associated with hemorrhage; those of the stomach and intestines, with septic extravasations; of the kidney, ureters, and bladder, with the escape of urine; of the gall-bladder, with that of bile.

The SYMPTOMS, if any, are those of hemorrhage, of peritonitis, or of both. (See Rupture of Abdominal Viscera.)

The TREATMENT requires exploration in all cases. Hemorrhage must be treated by ligation, tamponage, or, in extreme cases, excision of the organ (spleen, pancreas, or kidney) if that is possible. Extravasations, intestinal, gastric, urinary, biliary, and pancreatic, require repair of the rent, or, if that is impossible, drainage, with general peritoneal cleansing. Intestinal coils too extensively cut for repair or necrotic from injured blood-supply require excision.

Gunshot wounds of the abdominal viscera have an importance far greater than incised or stab wounds. The lesions are more severe, their complications more frequent, their results more disastrous. Gunshot wounds of modern civil life are chiefly produced by revolvers of moderate dimensions, carrying missiles of .22, .32, .38, rarely .44 calibre. Abdominal gunshot wounds are usually homicidal and accidental rather than suicidal. For the study of gunshot wounds of battle the reader is referred to works on military surgery.

Gunshot wounds as considered in this article are usually produced at short range. The force of the impact is great, the penetration extending often to complete perforation. The clothing is often burned, the skin contused.

The direction of flight may vary from a straight line to one of inexplicable curves. The point of impaction or of exit indicates, therefore, with reference to the point of entrance, a definite anatomical track or one so tortuous that the observer may be completely deceived. In its course through the abdomen the missile may cause irreparable damage or trivial laceration. Shock may be severe or mild, and in no way proportionate to the external injury.

The SYMPTOMS of gunshot wounds of the abdomen are those of hemorrhage, peritonitis, or both. (*Vide* Peritonitis and Hemorrhage.)

TREATMENT.—In gunshot wounds involving the abdominal cavity exploration by laparotomy is always indicated in the first hours; after an interval of six hours or more without symptoms of either hemorrhage or peritonitis the treatment may be expectant. In other words, all gunshot wounds in which injury to the abdominal viscera may have occurred demand exploration if seen immediately. Symptoms appearing late—localized peritonitis and abscess—should be treated by exploration, incision, and drainage. (See Peritonitis.)

A *gunshot wound of the abdomen*, when seen directly after infliction or within an hour or two, *demands immediate investigation* whatever the symptoms. The wound of entrance must be explored under complete anæsthesia. If it appear that the missile has been deflected from the peritoneum, an antiseptic pad to the wound of entrance will suffice. If penetration of the abdominal cavity has taken place, either the wound must be enlarged or an incision must be made over the viscus most probably involved. In doubtful cases is required a median incision, even if the wound of entrance is remote. When the line of flight is toward or even across the centre of the abdomen, that incision should be selected

which permits the most efficient exploration of the whole abdominal cavity.

As soon as the peritoneum is nicked the escape of blood, of serum, or of gas and fecal matter will show that further exploration is necessary. When nothing abnormal appears at the peritoneal incision, further exploration is wise, to make sure that no serious lesion can possibly exist. Doubtless the external wound may safely be closed in most cases.

Serious lesions must be treated according to their situation and character—hemorrhage by ligation of vessels or by gauze tamponage; intestinal, gastric, gall-bladder, and urinary-bladder rents by suture. (See Rupture of Stomach and Intestine, and Hemorrhage.) If the hemorrhage has ceased, the blood in the abdominal cavity should be thoroughly removed.

Intestinal extravasation requires most thorough investigation and repair. Every wound must be sutured with extreme care; coils too badly lacerated for suture may require excision with suture, anastomosis, or artificial anus. (See Operations on Intestine.) In extreme cases the injured bowel may be sutured temporarily into the abdominal wound. Inasmuch as the intestinal perforations may be multiple, and some of them hard to find, inflation of the gut through the anus with hydrogen (Senn), with air, or with fluid may be employed to demonstrate the integrity of the bowel-wall.

Gunshot wounds of the abdomen of *some hours' standing* require exploration if symptoms of persistent hemorrhage or of peritonitis exist. For hemorrhage the usual methods of treatment should be applied; for peritonitis the treatment of peritonitis (*q. v.*). Intestinal perforations must be closed and the peritoneal cavity cleansed.

When seen after the *lapse of a few days* gunshot wounds of the abdomen are likely to present only the symptoms of localized peritonitis and abscess, for cases of severe hemorrhage and of penetrating intestinal wounds no longer survive. Localized peritonitis and abscess require incision and drainage.

Gunshot wounds of the liver, spleen, pancreas, kidney, and bladder, ureters, and great vessels require the surgical repair practicable—hemorrhage by ligation and gauze tamponage; lacerations destroying the utility of the organ, by excision when possible; rents with extravasation, by suture.

In all cases of gunshot wounds examination of the superficial structures of the part of the body opposite to the wound of entrance must be made. Emergence of a bullet is often prevented by the elasticity of the skin. Not that removal of a bullet is important, however, though its extraction is always a matter of satisfaction.

Gunshot wounds unexplored should be disinfected as well as possible, and sealed with an antiseptic pad.

In thin patients the presence of bullets and certain other foreign bodies may be detected by the use of the Röntgen rays.

SURGERY OF THE STOMACH.

Congenital Malformations of the Stomach.—The stomach may be transposed; it may be abnormally small. Atresia of the pylorus has been observed, usually associated with hypertrophy of the muscular walls of the stomach; also hour-glass constrictions unaccompanied by signs of previous disease. Surgical interference is demanded but rarely in these conditions. (For acquired malformations see Ulcer and Dilatation of the Stomach. For Rupture, Contusion, and Penetrating Wounds of the Stomach see page 340.)

Ulcer of the stomach has recently acquired surgical importance from the encouraging results which have followed prompt interference in hemorrhage and in perforation, lesions previously regarded, if not necessarily fatal, as beyond relief.

Ulcer of the stomach occurs usually in young girls, though it may appear in both sexes at any age. The *direct cause* of ulcer is *ischæmic necrosis* of a circumscribed area of the gastric wall, due to diminished vascular supply, the etiology of which is obscure. The ulcers are usually single and small, and are situated most frequently near the pylorus, along the lesser curvature. They may be extensive or multiple, however, and involve other portions of the stomach. The shape is usually that of a truncated cone, the base of which is toward the interior of the stomach. The local necrosis is followed by digestion of the necrotic tissues. In the course of the digestive and gangrenous process an artery of considerable size, such as the gastric, may be eroded and cause alarming hemorrhage. From the whole ulcerated surface a slow capillary ooze may take place. The process may not stop with the digestion and separation of the sphacelus; it may continue even till perforation of the stomach wall ensues. The overlying peritoneum may become infected and adherent to contiguous structures. By this provision perforations are limited to the gastric wall or the neighboring viscera. Rapid necroses not shut off by adhesions from the peritoneal cavity permit immediate extravasation of the gastric contents. The cicatricial tissue resulting from the spontaneous healing of gastric ulcers may cause deformities in the stomach (hour-glass stomach) or stricture at or near the pylorus.

SYMPTOMS AND COURSE.—Gastric ulcer may give rise to no symptoms whatever until sudden perforation or hemorrhage occurs. In other cases epigastric pain and discomfort suggest the lesion. The usual symptoms are gastric irritation and discomfort, with more or less pain. Vomiting after eating sometimes occurs. The pain is boring in character, and is often referred to the back : hemorrhage causes either vomiting of blood, usually bright in color, or tarry stools. Continual persistent hemorrhage produces a characteristic waxy anæmia. The most important symptoms surgically are those of hemorrhage and of perforation. In perforations guarded by adhesions no symptoms, except those of the ulcer itself or of local peritonitis, are usually present.

Perforations into the abdominal cavity cause the symptoms of a general peritoneal infection. (See General Peritonitis.) Occasionally, as the result of perforation, abdominal abscess, pyothorax, subphrenic abscess, abscess of the pancreas and spleen, with or without perforation of the diaphragm, are observed. (See Subphrenic Abscess.)

The DIAGNOSIS of gastric ulcer rests upon the symptoms above given. It must be differentiated from cancer of the stomach—a distinction usually easy. Simple ulcer of the stomach, occurring at an age when cancer is common, can only with difficulty be distinguished from the latter. The chief diagnostic points of difference are the duration of the symptoms, the age of the patient, the presence of hydrochloric acid in excess, and the absence of the characteristic cachexia of cancer. A localized movable tumor favors the diagnosis of cancer. (See also Cancer of the Stomach.)

TREATMENT.—*Surgical interference in gastric ulcer is indicated*—(1) in the symptoms of rapid and dangerous *hemorrhage ;* (2) in the *anæmia* caused by the persistent, slow loss of blood ; (3) in *perforations* with general extravasation ; and (4) in *localized peritonitis with abscess.*

The exploratory incision made in the median line may be extended transversely in case the stomach is contracted or small. The anterior

surface and the lesser curvature, where the lesion is most apt to occur, should be examined first. By separating the layers of the lesser omentum most of the posterior wall of the stomach can be examined, digitally or visually. Inflammation of the peritoneum frequently shows the seat of the ulcer. In some instances the lesion can be detected by the sense of touch. The seat and extent of the ulcer having been determined, the disease may be treated (1) by infolding the whole ulcerated area; (2) by excision of the ulcer with subsequent suture; (3) by uniting the peritoneum around the ulcer to the abdominal wound; (4) by walling off the ulcer from the general peritoneal cavity with sterile gauze.

The choice of methods depends upon the symptoms which indicate interference—whether from hemorrhage or from perforation. For perforations, infolding, excision, suture to the wound, or gauze packing may be practised, according to the size, shape, and situation of the lesion; for hemorrhage, all the methods except infolding.

(1) Infolding consists in uniting the lax walls of the stomach over the affected area, which is deeply depressed for this purpose by the fingers or by an instrument. The peritoneum is united by means of continuous or interrupted Lembert sutures.

(2) Excision and suture are applicable in both hemorrhage and perforation. The tissues should be freely excised beyond the limits of the disease, and the wound closed by inverting the peritoneum with a continuous or an interrupted stitch. The direction of closure must depend upon the size and shape of the resulting wound.

(3) Suture to the abdominal wound is to be resorted to when the gap resulting from excision is such that closure of the stomach is impossible or in cases in which excision is for some reason impossible.

(4) Packing with gauze remains as the only resort in case neither suture of the stomach nor approximation to the abdominal wound is possible. Ulcers in the posterior wall may require this method of treatment.

If *hemorrhage* into the stomach is *alarming*, the stomach should be opened so as to give a clear view of the field. The bleeding surface may then be ligated or cauterized. If an artery of considerable size is bleeding, a thread may be passed under it by means of a curved needle and tied. The stomach wound may then be closed or it may be united to the ventral cut. Localized peritonitis with abscess should be treated by incision and drainage. Perforations guarded by adhesions may result in gastric fistulæ. (See Gastric Fistulæ.)

Localized peritonitis, when spontaneously healed, may result in painful adhesions to contiguous viscera, especially the duodenum, gall-bladder, and pancreas.

Subphrenic abscess may arise from any cause by which the lesser cavity of the omentum or the under surface of the diaphragm becomes infected. The most common cause is the perforation of a gastric or duodenal ulcer; more rarely extension of infective perforations of the vermiform appendix or of the gall-bladder. Subphrenic abscess either makes its way to the surface by adhesions or it breaks into the peritoneal or into the pleural cavity. Adhesions to the diaphragm, especially on the left side, may cause rupture into the pleural cavity or into the pericardium. A pyo-pneumothorax without other cause should suggest the possibility of direct infection through the perforation of gastric ulcer or indirect through the rupture of a subphrenic abscess.

The SYMPTOMS of subphrenic abscess are those of a deep epigastric

inflammation—pain, fever, with constitutional infection. A tumor may be felt in the epigastrium, or even in the region of the liver or of the spleen.

The DIAGNOSIS is often difficult on account of the deep situation of the affection. It depends (1) upon a history of gastric ulcer; (2) upon the local signs of an epigastric tumor, with local pain and tenderness and general systemic disturbances; and (3) upon aspiration. Unless the swelling is at the surface, aspiration is too dangerous to be employed for diagnostic purposes.

The TREATMENT of subphrenic abscess is **drainage**. This should be accomplished, if possible, without breaking down adhesive barriers. The incision should therefore be made over the most prominent portion of the tumor. In case the anterior abdominal wall is not adherent, and in case the abscess does not point externally elsewhere, incision and drainage must be made through the median line above or below the stomach, according to the situation of the tumor. Subsequent treatment should be like that of other abdominal abscesses.

Abdominal abscesses resulting from the perforation of gastric ulcers or from other causes in the immediate vicinity of the stomach give rise to localized, tender, and painful tumors with characteristic physical signs. They should be treated like abscesses elsewhere.

Gastric fistulæ result usually from the perforation of gastric ulcers through the anterior wall of the stomach and of the abdomen. They may be caused, however, by direct injuries to the stomach or by the presence of foreign bodies. Internal fistulæ result from perforations into contiguous portions of the alimentary tract. The latter rarely give rise to symptoms.

Gastric fistulæ, like intestinal, *usually heal spontaneously.* Such as do not by themselves close under cleanliness and stimulation may be treated by nitrate of silver, the actual cautery, mechanical approximation by means of straps or crêpe lisse, or by resection of the sinus, with suture.

After the failure of persistent efforts in this direction *closure* may be ensured by separating the stomach from the abdominal wall, so that the freed and lax edges of the gastric opening may be resected, inverted, and sutured. The complete separation of the stomach usually necessary in this procedure causes some danger of general peritoneal infection. Care must be taken, therefore, to prevent the escape of gastric contents. Preliminary lavage is essential. The whole stomach being freed from its attachment, inversion and suture are easy. A strand of gauze should be left in the abdominal wound in contact with the line of suture to provide against extravasation.

NEW GROWTHS OF THE STOMACH.—Though *carcinoma* is by far the most important neoplasm of the stomach, *sarcomata, adenomata,* and *myo-fibromata* have been observed. The last three, from their rarity, have little surgical importance, though one or two large sarcomata and one adenoma have been removed from the stomach-wall.

Cancer of the Stomach.—Cancer is more frequently seen in the stomach than in almost any other part of the body. It is usually of the *scirrhous* variety, and is a disease of adult or advanced years. Cancer is situated usually at the *pylorus*, less frequently at the cardia, and least frequently in the main body of the stomach.

The CAUSE of cancer of the stomach is uncertain. The growth may involve the inner layers of the stomach as a flat, eroded surface unaccompanied by tumor. The affected walls, on the other hand, may be thickened, sometimes to an extreme degree, so that the tumor may be felt through the epigastrium. In other cases no tumor will be perceptible. At times the whole anterior wall of the stomach is infiltrated with an enormous mass of new growth. The internal surface of the cancer may become necrosed and eroded; digestion of the necrotic area may result in hemorrhage or in perforation. The edges of the ulcer are irregular, the base uneven and necrotic; the gastric wall may be excessively thickened or by ulceration thinned and friable. The peritoneum over the affected surface may become adherent to surrounding organs. *Perforations* may take place and cause fatal peritonitis, or limiting peritoneal barriers may guide the extravasation into other viscera. Infection of the lesser omental cavity may result in subphrenic abscess; of contiguous viscera, in localized abscesses; of the abdominal cavity, in peritonitis.

The *hemorrhage* in cancer is usually slight. Digestion gives the blood the familiar coffee-grounds color.

Cancer situated at the pylorus often causes stricture with dilatation of the stomach. The infection of lymph-nodes appears late, if at all.

SYMPTOMS.—The first symptoms of cancer of the stomach are disturbances of digestion, generally associated with constipation. Pain is next observed, sharp in character and aggravated by food, with vomiting after eating, gradual loss of weight, and cachexia. The vomitus often contains digested blood resembling coffee-grounds. Free hydrochloric acid in the gastric juice may be diminished or wanting in extensive gastric cancer. Too much reliance must not be placed upon this symptom, because hydrochloric acid may be diminished or absent in certain other diseases, and because, even if present in normal amounts, gastric cancer may nevertheless exist.

The *tumor of gastric cancer* is often imperceptible, especially in the early stages, when radical operative extirpation is possible. When conspicuous, the tumor is usually situated at the pylorus or in the anterior wall. Situated in the posterior wall or near the cardia, it cannot, unless very large, be detected by palpation.

The tumor of gastric cancer is usually hard and tender; it may be smooth or nodulated, globular and sharply defined, or a flattened oval and gradually merging into the surrounding structures. It may be superficial and extensively mobile or firmly and deeply fixed. At times the tumor will be found with extensive contiguous metastases. The relation of the tumor to the stomach can usually be determined by the aid of lavage, inflation, or by the use of the gastro-diaphanoscope. Cancer-cells can sometimes be detected in the vomitus or in the washings. Dilatation of the stomach, often to an extensive degree, due to pyloric obstruction, is usually present.

The *chief points of difference between ulcer and cancer* of the stomach are as follows: Cancer occurs usually at or after adult life, ulcer in late youth. Pain, usually present in cancer, is sharp, referred to the shoulder, and increased by food; that of ulcer, boring through the back, relieved by food. Blood vomited in ulcer is usually fresh and bright; in cancer it resembles coffee-grounds. In cancer there usually is a tumor; in ulcer, none. The symptoms of ulcer often extend over a long period of time without affecting markedly the weight, general appearance, or strength; cancer, a progressive disease of comparatively short duration, affects early and profoundly the constitution. In ulcer the cachexia is usually that of loss of blood—a distinct anæmia; in cancer, even with the loss of blood, it is conspicuously the cachexia of malignancy. Free hydrochloric acid is diminished or absent in cancer; it is increased in ulcer.

The surgical TREATMENT of cancer of the pylorus is either radical or palliative. Pyloric stenosis requires either radical excision of the disease with suture, or anastomosis between the stomach and the jeju-

num. Perforations with extravasation may require immediate interference and repair unless the patient's chances of life are, from the advanced condition of the disease, necessarily too small to make surgical intervention worth while. Hemorrhage is rarely severe enough to demand operation. Even if extensive, the wisdom of surgical intervention may well be questioned. When palliation and medical treatment are unsuccessful, the shock of operative measures is not likely to be safely borne by an exsanguinated patient.

Stricture of the Pylorus.—The causes of pyloric stricture are—

(1) Congenital malformations;
(2) Cicatricial contraction of ulcers;
(3) Malignant and benign tumors;
(4) Twists at or near the pylorus;
(5) External pressure from growths;
(6) Spastic contractions.

Congenital atresia, though very rare, has been observed. Cicatrized ulcers situated near the pylorus frequently result in permanent stenosis. The lumen may be considerably diminished without causing symptoms; it may be more or less restored by ulceration after a temporary narrowing. Complete atresia is rarely, if ever, seen. *Malignant disease* involving the pylorus obliterates it more or less completely. *Twists* may take place in the pylorus of a dilated stomach, especially when the abdominal walls are extremely relaxed. *Tumors* of the liver, the gallbladder, the pancreas, the omentum, or the retroperitoneal space by pressing upon the pylorus may diminish its lumen. Movable kidney and spleen have been said to cause obstruction by dragging on the stomach. The existence of spastic stricture of the pylorus is doubtful.

The SYMPTOMS of pyloric stenosis are those of dilatation of the stomach—malnutrition and impaired digestion, with decomposition of food. The dilatation may be extreme; the stomach may extend into the left flank, into the pelvis, or even into the right flank. Sagging with fluid and distended with gas, it gives rise to marked succussion.

The palliative TREATMENT of dilated stomach is systematic lavage, massage, and electricity. Dilatations which result from atony may be so much improved by this treatment that operative measures are unnecessary. The *radical treatment* of pyloric stenosis consists in *mechanical dilatation* (Loreta's operation), *pylorectomy, pyloroplasty, gastro-enterostomy,* or *pylorectomy combined with gastro-enterostomy.* (See Operations on the Stomach.)

FOREIGN BODIES IN THE STOMACH.

Foreign bodies in the stomach may have been swallowed as a single object or they may have been gradually formed of small, indigestible substances agglutinated. The commonest foreign body is a plate of teeth. Almost every conceivable thing that can be held in the mouth has been swallowed. Large balls of hair and straw have been found in the stomachs of the insane. As a rule, a rounded body that can pass the œsophagus will also pass the pylorus. Sharp or angular objects frequently fail, however, to pass this orifice.

Foreign bodies in the stomach may give rise to no SYMPTOMS whatever. If very large, they may cause obscure digestive disturbances. If small enough to become impacted, but too large to pass the pylorus, symptoms of obstruction ensue. Sharp objects penetrating the stomach-wall may give rise to localized or to general peritonitis.

The indications for operation upon the stomach in cases of suspected foreign bodies are pain, localized tenderness, fever, and the physical signs of pyloric obstruction or extravasation. Gastrotomy is the operation indicated for removal. (See Gastrotomy.)

OPERATIONS UPON THE STOMACH.

PRELIMINARY TREATMENT.—Whenever it is proposed to open the stomach, preliminary lavage and rectal feeding should be employed, for it is essential that the stomach be both empty and clean. It may be washed out with warm water or with a solution of boric acid.

Gastrotomy—*i. e.* making a temporary opening into the stomach—is resorted to in the extraction of foreign bodies and as a preliminary step to certain operations upon the œsophagus and upon the pylorus. The incision through the abdominal wall, two or three inches in length, should be made in the median line above the umbilicus. When the stomach is small and contracted the cut must be enlarged longitudinally and sometimes transversely.

The principal care in opening the stomach should be to prevent extravasation of its contents; hence the importance of preliminary lavage and of gauze placed about the line of the proposed gastric incision. The stomach should be incised in the longitudinal axis, halfway between the greater and the lesser curvatures. If but a small opening is necessary, it may be made transversely. Operations upon the œsophagus can best be accomplished by an incision not far from the pylorus. By putting the lesser curvature on the stretch a sulcus is made through which the instrument glides into the œsophagus. **For operations upon the pylorus** the cut must be made near enough to permit easy reach of the pyloric orifice by the finger. In extracting foreign bodies care must be taken not to lacerate the edges of the gastric incision. In closing the wound of the stomach the mucous membrane should first be united by a continuous suture. After this the serous edges should be inverted and fastened by the interrupted Lembert, by the Halsted quilted suture, or by the continuous Lembert. As a rule, the joint will be so satisfactory that the external wound may be closed immediately. In cutting through the stomach-wall the hemorrhage is chiefly from the mucous membrane. This can be controlled by the continuous suture.

Gastrostomy consists in making a permanent opening into the stomach. It is indicated in inoperable strictures of the œsophagus, malignant or benign. The operation was first performed successfully in 1874.

By the early methods the stomach was first stitched to the abdominal wound; some days later, after it had become firmly adherent, a permanent opening was made.

Fenger exposed the organ by an incision along the left costal border; Von Hacker, by a cut through the left rectus muscle.

Fig. 153.
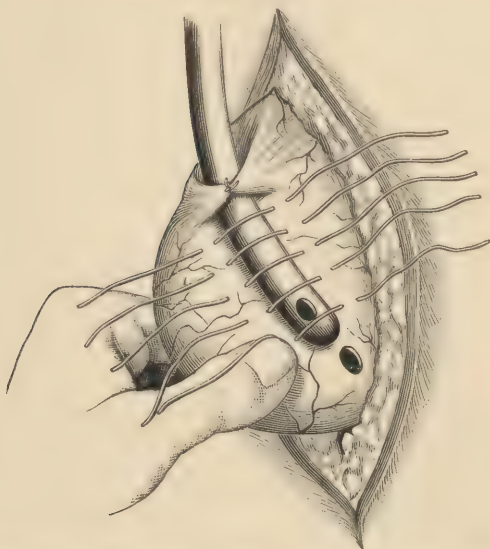
Gastrostomy: Witzel's method. Tube in position; sutures ready to tie.

The disadvantage of the early operations was leakage. Of the recent methods, devised to obviate this difficulty by making an oblique fistulous tract in the stomach-wall, that of Witzel is the most efficient. By this

Fig. 154.
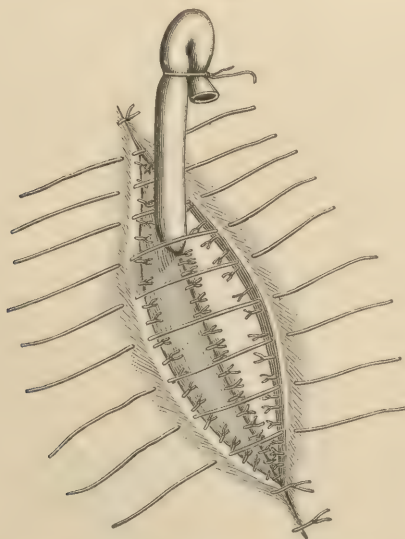
Gastrostomy: Witzel's method. Tube in position; sutures ready to close abdominal wall.

method a tube is infolded in the stomach-wall by peritoneal approximation, as shown in Fig. 153. The stomach is stitched to the abdominal wall (Fig. 154), and the external wound is closed.

The manipulations can usually be made outside the peritoneal cavity. No secondary operation to open the stomach is needed. Feeding through the tube may begin immediately after the operation. The tube should not be removed for the first time until the expiration of a week. Contraction of the fistula may be prevented by removal and reintroduction of the tube at frequent intervals.

Loreta's operation consists in preliminary *gastrotomy and digital or instrumental dilatation of either the cardiac or the pyloric orifice of the stomach* in cases of non-malignant stricture. This operation was first performed in 1882. The majority of the cases have been stricture of the pylorus. In the preparation of the patient and the opening of the stomach the technique does not differ in any way from that of gastrotomy. The gastric incision should be within easy digital reach of the

Fig. 155.
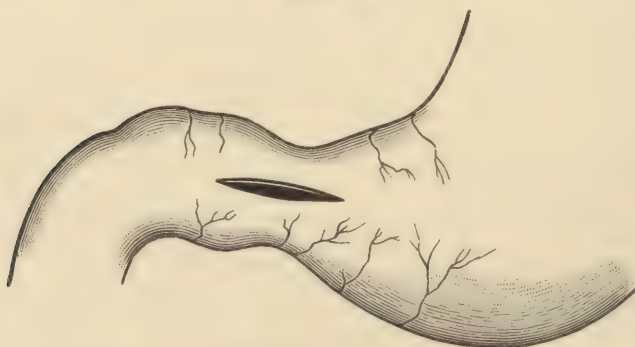
Pyloroplasty: incision.

pyloric opening, and should be in the longitudinal axis. Dilatation of the stricture should be carefully effected by means of one or more fingers

Fig. 156.

Pyloroplasty, showing gain in calibre by method of suturing.

or by bougies. Hemorrhage and rupture of the stomach may complicate this operation; the stricture may recur.

Pyloroplasty rather than digital divulsion should be the operation of choice for benign strictures of the pylorus. It consists in taking out

a double V- or diamond-shaped piece in the longitudinal axis of the pylorus, on the anterior surface, as in Fig. 155. This incision is sutured transversely, as shown in Fig. 156.

Pylorectomy.—Pylorectomy, or resection of the pylorus, was first successfully performed by Billroth in 1881. The operation is indicated in malignant strictures of the pylorus in which the disease is limited to the stomach, and in benign strictures in which a pyloroplasty will not

Fig. 157.
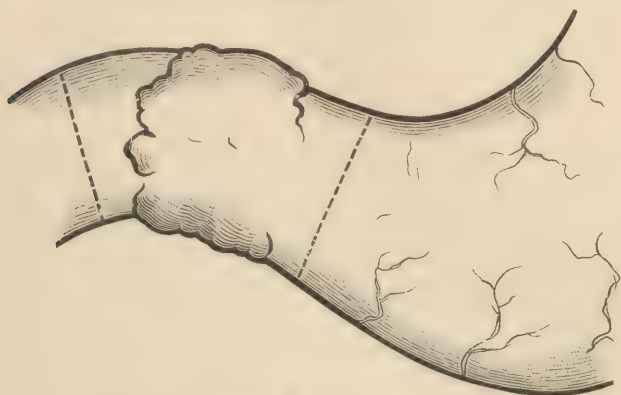
Incision for pylorectomy.

afford relief. Preparation for the operation consists in rectal feeding and gastric lavage.

The stomach should be exposed by a median abdominal incision

Fig. 158.
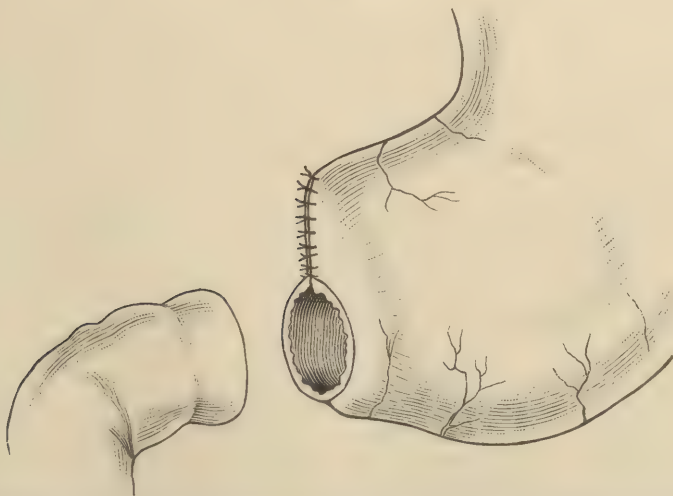
Pylorectomy: pylorus excised; stomach-opening partially closed, ready for suturing to the duodenum.

above the umbilicus, long enough to permit free inspection and manipulation. The stomach and upper part of the duodenum should be pulled

out of the wound, and the abdominal cavity walled off with gauze. Resection of the diseased portion should be thoroughly effected by cutting well above and below the lesion through sound tissues. The resulting openings in the stomach and duodenum must next be fitted together according to their size and shape, as suggested in Figs. 158, 159. If they cannot be satisfactorily united, these openings must be closed and a gastro-enterostomy performed (*q. v.*). (See Figs. 158, 159.)

Coaptation of the divided structures should be made by the Lembert stitch. (See Figs. 158, 159.) To prevent extravasation, strands of

Fig. 159.

Pylorus resected: gastro-enterostomy completed.

sterile gauze may be placed against the line of suture and led out of the abdominal wound; these may be removed on the third day.

The *mortality of pylorectomy* has been very high (over 70 per cent.); this is due mainly to the unfavorable nature of many of the cases.

Combined pylorectomy and gastro-enterostomy consists in excision of the pylorus, closure of the divided stomach and duodenum, and the formation of a lateral anastomosis between the stomach and the jejunum.

This procedure has had a mortality slightly less than pylorectomy, probably due to the greater rapidity with which it may be accomplished.

Gastro-enterostomy is an anastomosis between the stomach and some portion of the intestine, preferably the jejunum. It is indicated in cases of malignant disease of the pylorus in which the process has extended to the walls of the stomach, or in which neighboring structures are involved, or when there is extensive metastasis. It is sometimes indicated in benign stenosis with extensive adhesions, in which pylorectomy, pyloroplasty, or dilatation is impossible.

Gastro-enterostomy should be performed by joining a loop of intes-

tine to the posterior wall of the stomach by sutures or by some mechanical aid (Fig. 160). Von Hacker in 1883 showed that anastomosis on

Fig. 160.
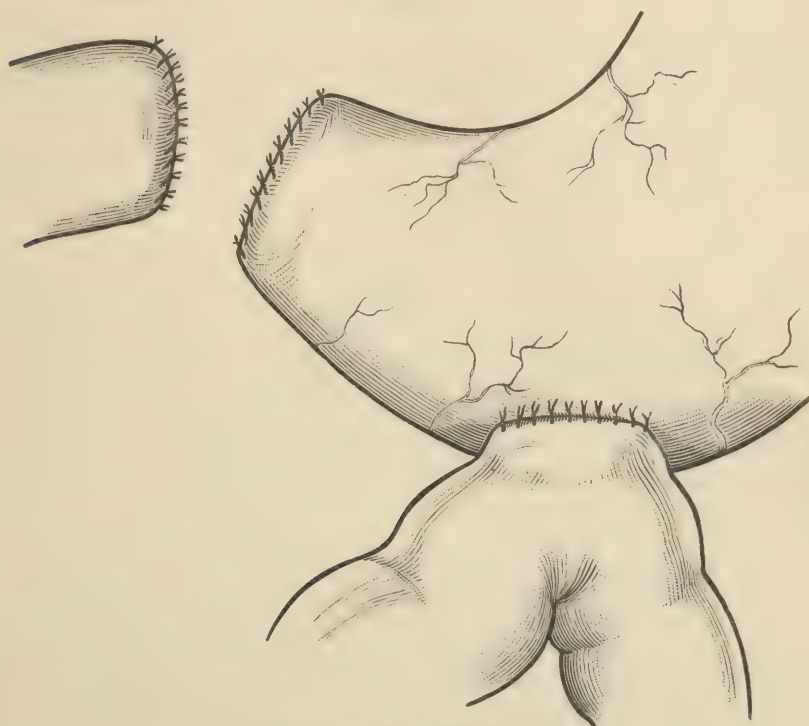
Pylorectomy: gastro-enterostomy.

the posterior stomach-wall was essential, but this cannot be accomplished when the stomach is bound down by adhesions.

To prevent stagnation of food and bile in the unused portion of the duodenum several additional anastomoses between intestinal coils have been suggested by Braun.

Gastrorrhaphy is an operation devised to reduce the size of a dilated stomach. It has been performed but rarely, and consists in making a single or double plait in the anterior wall of the stomach, the peritoneal surfaces being sutured together to hold the folds in place. Theoretically it may be successfully applied in cases of simple chronic dilatation which are not relieved by lavage.

Operations for Painful Gastric Adhesions.—Adhesions of the stomach to the abdominal wall or to the neighboring viscera, occurring as a remote result of gastric ulcer, may cause severe gastralgia. In numerous cases, after failure of palliative treatment, exploratory laparotomy with free division of the adhesions has effected a complete cure.

Gastro-anastomosis consists in making an anastomotic communication between the cardiac and the pyloric ends of the stomach in cases of extreme hour-glass contraction of that organ. The operation has been performed but three times up to the present year (1896).

SURGERY OF THE INTESTINES.

(For wounds and ruptures, see page 340; for non-traumatic perforations, see Typhoid Ulcers, Tuberculosis, Cancer, Appendicitis, and Fecal Fistulæ.)

The most important anomaly of the intestine is *Meckel's diverticulum*, which from its possible situation, size, and relations may cause acute obstruction or bowel-necrosis, or both.

Congenital atresiæ may occur at the ileo-cæcal valve and in the ileum and the jejunum. Doubling of the small intestine, a rare and unimportant anomaly, has been observed.

Intestinal Obstruction.

Intestinal obstruction may result from lesions which contract or obliterate the intestinal lumen, or it may be dependent upon a *paresis of the muscular wall* of the bowel, of septic or of inflammatory origin. The former only are considered as true obstructions.

Acute obstructions are caused, as a rule, by mechanical lesions not associated with disease. *Simple mechanical closure* of the intestinal canal may be congenital; it may be caused by intussusception, volvulus, internal and external strangulation, kinks and flexures, and the impaction of foreign bodies. The *passive obstruction* dependent upon intestinal paresis is seen in general peritonitis, in mesenteric embolism, and thrombosis.

Chronic obstructions are caused by disease—by new growths, benign and malignant, involving the intestinal wall, by the pressure of external growths and inflammatory masses by cicatricial strictures after intestinal ulceration. Chronic and intermittent obstructions sometimes occur as the result of faulty adhesions and internal incarcerations.

Acute Intestinal Obstruction.—*Bands, Kinks, and Flexures; Internal Strangulation.*—The commonest form of mechanical obstruction is that due to the various forms of external *hernia*. (See chapter on Hernia.) A *Meckel's diverticulum* may cause acute obstruction with strangulation either of itself or of an intestinal coil. *Bands* occasionally exist without antecedent inflammation and without interfering with the intestinal stream; they may suddenly, however, without apparent cause, produce complete or partial obstruction. A protrusion of the intestine through an opening in the mesentery or in the omentum or under a band resembles greatly the lesion of an ordinary hernia, and has been called internal strangulated hernia. *Retroperitoneal hernia*—*i. e. prolapse* of the intestine into an abnormal peritoneal pouch, either at the fossa duodeno-jejunalis or in the region of the cæcum or the sigmoid flexure —is a form of internal hernia that may cause acute obstruction.

Strangulation of an intestinal coil through the *foramen of Winslow* is a very rare accident. Foramina in the mesentery or in the omentum cannot be explained except as the result of trauma, of operation, or of congenital influences. *Kinks and flexures* result from faulty adhesions. *Bands* dependent upon such adhesions may occur after any form of general or of partial peritonitis, after operations, in the course of ectopic gestations, and without known cause. *Adhesions* in their effects may vary between extreme limits. A single point of faulty attachment may

produce a constricting loop; on the other hand, a total matting together of intestines, uterus, tubes, and ovaries, no mechanical obstruction whatever.

As a rule, the former is more productive of obstruction than the latter. A single band may compress the intestine transversely or it may strangle a whole coil. Kinks and flexures are produced by the adherence between a coil and a contiguous viscus—between the small intestine and a uterine horn, or between the intestine and the scar of a vaginal hysterectomy. Changes in the size of the uterus or in the depth of the contracting vaginal cicatrix may drag the adherent coil into a sharp angle, by which, under ordinary conditions, no obstruction is produced. Distention of the proximal coil by pressure against a solid viscus or against the

Fig. 161.
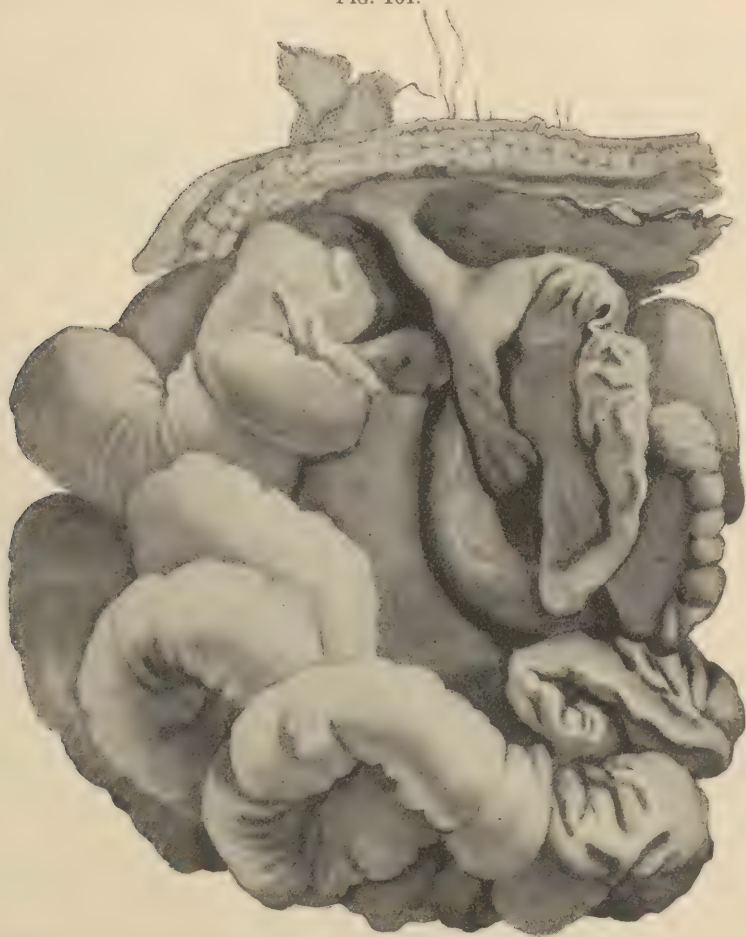
Meckel's diverticulum causing fatal obstruction (Dr. H. W. Cushing, Warren Museum).

pelvic brim may suddenly occlude the outlet into the distal lumen, producing a valve which is tightened more and more by the increasing distention. Separation of the adhesion at once relieves the tension, opens the valve, and restores the lumen.

The intestinal coils are frequently extensively matted together, at times with more or less obstruction. Single or multiple fistulæ occasionally exist between the coils.

Congenital obstructions, though rarely found except in the rectum and the anus, have been observed in the duodenum, the jejunum, the ileum, and at the ileo-cæcal valve. Congenital defects due to Meckel's diverticulum are much more important. In this malformation, the ileum either communicates directly with the umbilicus or is attached to it by means of a fibrous cord or band. Pressure from this prolongation not infrequently results in strangulation of an intestinal coil or of the diverticulum itself. (See Fig. 161.)

Acute obstructions result occasionally from the impactions of foreign bodies, gall-stones, enteroliths, and *intestinal worms.* Foreign bodies seldom become impacted in the intestine after leaving the pylorus unless they have sharp edges or angles. Objects small enough to pass the normal intestine may cause pathological changes by which they become permanently arrested; ulceration and even perforation may result, with cicatricial stricture as a remote possibility. When stricture is present a body no larger than an orange- or apple-seed may produce the first symptoms of obstruction. *Enteroliths* are usually formed upon gall-stones, though they may be composed entirely of fecal substances or of phosphates combined with animal matter. Obstructions from *gall-stones* usually occur in women of advanced age. The calculi make their way by slow ulceration from the gall-bladder into the duodenum. The seat of the impaction is usually in the small intestine. (See Plate VIII.)

Intestinal obstruction by *masses of round-worms* has occasionally been observed in children.

Intussusception.—Of all the cases of acute intestinal obstruction, 30 per cent. are due to intussusception. The majority of cases occur in children. Among adults it is more common in women than in men. The situation of an intussusception is usually at the ileo-cæcal valve, the small intestine being invaginated into the large. The process may be confined, however, to the small intestine. In rare instances a double invagination may occur, or even a retrograde telescoping.

Pathology.—An intussusception consists of three layers of bowel, that which is received being called the *intussusceptum,* and that which receives, the *intussuscipiens* (Figs. 162, 163).

Most of the cases are at the ileo-cæcal valve. Spontaneous recovery by sloughing and elimination of the intussusceptum occurs in about 40 per cent. of the cases, but spontaneous recovery is not always permanent, for death may take place subsequently from perforation of the intestine; moreover, stricture of the gut is very likely to occur. Recovery after intestinal resection in children with this form of obstruction is almost unknown. The longer operating is delayed the greater the mortality. Operations performed on the first or second day are by far the most successful.

The causes of intussusception are generally obscure; occasionally, however, they are obvious, as when an intestinal polyp is found. Predisposing causes are irregular peristalsis, feeble health, diarrhœa, adhesions of the bowel.

The symptoms of intussusception are chiefly those of acute intestinal obstruction, and are usually without premonition, though some predisposing causes may have been observed. The *pain,* rapidly increasing in severity, is due partly to violent intestinal contractions, and partly to dragging and pressure upon the mesentery, with distention of the intussuscipiens and beginning necrosis of the intussusceptum. *Vomiting, distention,* and *collapse* appear early. The *characteristic symptom is the*

PLATE VIII.

Enterolith with Gallstone for a Nucleus: Removed by Enterotomy.   (Richardson.)

passage of blood and mucus from the rectum. This form of acute obstruction unites with the symptoms of stenosis those of acute gangrene; hence the fulminating nature of the disease.

In rare instances, however, invagination may be slow, and the intussusceptum may accommodate itself to the altered conditions without necrosis and without violent symptoms. If the abdominal walls are thin and if distention is slight or absent, an ill-defined sausage-shaped tumor can generally be detected; if the abdominal walls are thick and if distention is excessive, the tumor, unless very large, cannot be felt. If the intussusception is low down, the invaginated bowel may be felt through the rectum.

TREATMENT.—The treatment of intussusception may be *palliative* or *operative. Palliative measures* include massage, rectal injections with

FIG. 162.   FIG. 163.
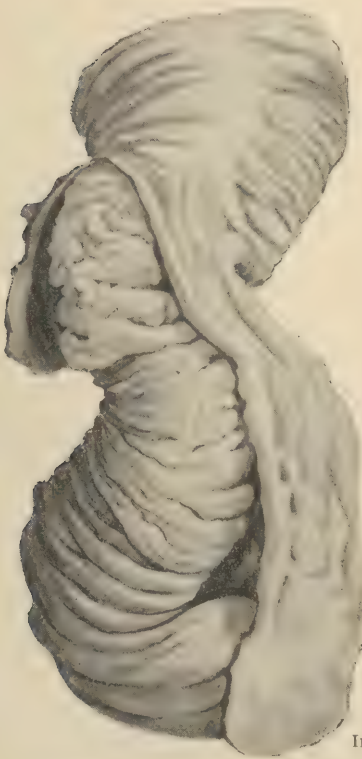
Intussusception (Warren Museum).

Intussusception at the junction of the small and large intestine. The former has passed outward and the cæcum retains its place, the appendix projecting from the neck of the invagination (Warren Museum).

the patient inverted, and inflations of the colon with air or gas. It is doubtful, however, in a clear case of intussusception whether time ought to be taken for palliation. The excessive mortality in this disease is largely due to delay in applying radical surgical treatment; it is best, therefore, if attempts at reduction by non-operative measures be used, that they be as brief as possible if not immediately successful.

Reduction of the invagination by inflation and enemata is not possible after the invaginated portion has become swollen from the constriction of its efferent

vessels and fixed by adhesions. In advanced cases the intussusceptum is presumably necrotic. Under such circumstances dilatation sufficient to force back the intussusceptum can hardly fail to burst the intestinal wall. If the abdomen were immediately opened in all cases, the mortality would doubtless be very much diminished. In the hands of general practitioners and operators of no experience the chances of recovery are probably better if the patient be left to purely medical treatment, for a certain number of cases recover spontaneously after sloughing and separation of the intussusceptum.

The **operative treatment of intussusception** consists (1) in the reduction of the invagination, (2) in resection and suture, and (3) in the formation of an artificial anus. The incision should be made preferably in the median line, unless the tumor, far to one side, requires for facile manipulation a cut directly over it. The situation of the lesion can usually be detected by the presence of a tumor and by the tense mesentery dragged upon by the intussusceptum. If the integrity of the bowel is not impaired, gentle efforts at reduction should first be made. If these be unsuccessful after prolonged trial, resection of the invaginated portion well above and below the constricting and the constricted portions of intestine should be made. The mortality of the procedure, however, is so excessive that the advisability of palliation by the formation of an artificial anus above the constriction should be seriously considered, especially if the strength of the patient does not admit of the prolonged manipulations of resection and suture.

Appendicitis, a condition of sufficient importance to receive distinct consideration in another part of this chapter, must nevertheless be enumerated here as a common cause of acute obstruction, which it produces by means of the adhesions resulting from copious exudate of plastic lymph about a compromised appendix. These are the cases often masked by the co-existence of a generalized septic or putrid peritonitis.

Volvulus.—In this rare form of acute obstruction the lesion may be produced by the revolution of a single coil about its mesentery or by the twisting together of two separate coils. An intestinal coil heavily loaded with fæces, hanging by a long mesentery, presents the most favorable condition for a twist. The most *common seat* of the lesion is the *sigmoid flexure*, where it is not unusual to find an enormously lengthened coil, which when distended stretches out in the form of a huge S from the left sacro-iliac synchondrosis to the liver, thence into the pelvis. Volvulus usually appears after middle life, and is four times as common in men as in women.

In a second form the twist usually involves the sigmoid flexure and a loop of small intestine, though it may be confined to two loops of small intestine. *A twist once formed is soon so fixed by adhesions* as to become completely and permanently obstructed.

SYMPTOMS AND DIAGNOSIS.—The symptoms of volvulus usually come on suddenly. *Pain*, in this as in other forms of acute obstruction, is an early, lasting, and important symptom. At first it is usually referred to the umbilicus, but later it becomes localized in the region of the lesion. If the twist be in the small intestine, *vomiting* is an early symptom; if in the large, a late one. The nature of the vomitus depends upon the seat of the obstruction; if high up, there is early regurgitation of the contents of the small intestine into the stomach. *Fæcal vomiting* is a late symptom when the volvulus is in the sigmoid

flexure. Distention of the twisted coil is due to decomposition of its contents and passive congestion of its walls. If the patient lives long enough and the twist is not reduced, necrosis of the bowel-wall, with extravasation, takes place, whereupon the symptoms of general peritonitis appear.

The COURSE of the disease is violent and fatal if relief is not afforded by early operation.

The DIAGNOSIS of volvulus cannot be made with certainty. If the symptoms of acute obstruction develop suddenly late in life in a patient habitually constipated, volvulus may be suspected. This suspicion may be strengthened by the detection of the ill-defined tumor of a distended and resistant intestinal coil. These symptoms, however, are present also in an intussusception; the absence of bloody stools would indicate rather a volvulus. An absolute diagnosis can be made only by exploration.

TREATMENT.—In the treatment of volvulus palliative measures are of no avail. By the time the formidable symptoms of acute obstruction have become manifest the intestine is fixed in its abnormal position. External manipulations accomplish nothing, and enemata do more harm than good. The lesion is a mechanical one, like the twist of an ovarian tumor upon its pedicle, and demands *immediate exploration.* Unfortunately, the unavoidable delay before surgical relief can be applied is in most instances so great that the mortality after operation is very high. By the time the affected coil can be untwisted the constitutional depression is extreme, especially in old people, and the local condition beyond remedy. If the bowel-wall be gangrenous or if the vessels be thrombosed, either resection of the whole coil or formation of an artificial anus is demanded. In either case death is likely to follow. As soon as the diagnosis has been made the abdomen should be incised in the median line, or over the distended coil if it can be felt. The cut should be long enough to expose the lesion completely, and to permit not only a most thorough examination, but easy surgical manipulations.

When the bowel is necrotic, the whole coil should be excised and immediate suture made if the patient's condition permits so prolonged an operation. If haste be necessary, the cut ends of the bowel may be sewed into the abdominal wound. To prevent recurrence the mesentery of the affected coil may be shortened by taking a tuck in it, (For the consideration of acute obstructions dependent upon embolism and thrombosis of the mesenteric vessels, see Surgery of the Mesentery.)

SYMPTOMS IN GENERAL OF ACUTE INTESTINAL OBSTRUCTION.— Symptoms of intestinal obstruction cannot be definitely divided into the acute and the chronic, because many forms of acute obstruction are dependent upon chronic disease. From the clinical point of view, the symptoms of obstruction may be divided into those which come on suddenly without antecedent causes, and those which appear slowly as a gradually increasing obstruction or as intermittent acute attacks of greater and greater severity. The symptoms of acute obstruction due to chronic disease, especially carcinoma, are found on careful questioning to have been preceded, in most instances, by obscure symptoms of the original disease.

Incomplete obstructions due to the pressure of bands, to internal incarcerations, and to similar mechanical lesions may exist for years without producing absolute stoppage of the intestinal stream. In such cases temporary obstruction

causes attacks of transitory colic which disappear spontaneously. Similarly a history of preceding attacks of pain is often elicited when acute symptoms suddenly develop in the course of chronic obstructions dependent upon organic disease of the intestinal wall. Serious apprehension may not have been aroused in any of these attacks. In most of the lesions causing acute obstruction no pre-existing symptoms dependent upon them could have existed. The symptoms of acute obstruction are pain, vomiting, diarrhœa, and distention, with a primary shock which varies in depth with the causative lesion. Constipation necessarily results.

To the above cardinal symptoms of acute obstruction are added in the course of a few hours those dependent upon bowel-necrosis and local or general peritonitis. (See Volvulus, Intussusception, Internal Strangulation, Mesenteric Embolism and Thrombosis.) In simple obstructions unattended by bowel-necrosis—in kinks, bands, flexures, the pressure of tumors, and the impaction of foreign bodies, gall-stones, and enteroliths, the cardinal symptoms above enumerated alone exist, though they increase to an extreme degree, and persist until relieved mechanically.

DIAGNOSIS.—The diagnosis of the variety of the lesion is of great clinical importance; for practical purposes, however, it is necessary to know only that some lesion exists demanding interference.

In *acute mechanical obstructions constitutional signs are at first absent;* peristalsis is increased; intestinal coils can be seen in contractions under the abdominal walls if they are thin; no pre-existing cause can be found; distention is at first local, later general. In *general peritonitis constitutional signs are present early;* peristalsis is diminished, then absent; no intestinal movements can be seen or heard; a pre-existing lesion can generally be demonstrated; distention is general. Common to both conditions are pain, vomiting, distention, shock. The pain of obstruction is paroxysmal; that of peritonitis, continuous. Vomiting, distention, and shock do not differ materially in the two lesions.

In the later stages of those obstructive conditions which cause gangrene differentiation must depend upon the history only. Except in the rarest instances an exploratory diagnosis is demanded by the chief symptoms common to both obstruction and peritonitis.

The diagnosis between the different forms of obstruction, though of considerable importance, does not justify prolonged observation or the employment of time-taking methods. Between the lesions of internal strangulations, bands, kinks, and between acute and chronic lesions in general, the distinction is at times impossible. As a rule, however, one is able to say whether the symptoms are due to a slowly progressing organic disease or to one of the acute varieties of mechanical obstruction. All acute obstructions come on suddenly, without previous symptoms. If acute obstructions occur in the course of chronic disease, a careful consideration of the history will bring out the fact, or will, at least, suggest it with some probability. Acute general peritoneal infection following the symptoms of acute obstruction suggests strongly those processes which begin in obstruction and end in gangrene. In intussusception and in volvulus certain characteristic signs appear—in the former bloody stools and a soft sausage-shaped tumor; in the latter, an obscure and resistant coil.

Symptoms of intestinal obstruction due to the paresis of a local coil, as seen in mesenteric embolism and thrombosis, may be considered in connection with lesions causing acute mechanical obstruction. A clear distinction is often impossible. The history of the case, with the presence of tense and resistant coils and with symptoms of a general infection early in the course of the attack, strongly suggest vascular stasis in the mesentery. Yet in volvulus the bowel-necrosis may come on early as the result of such stasis, and the distended coils may be felt as resistant masses through the abdominal wall. As a rule, however, the symptoms in volvulus are less violent than those in mesenteric embolism or thrombosis. Pain is a subordinate symptom in the latter.

Inflation of the rectum by gas or air may be employed as a diagnostic measure in the course of the palliative treatment of intussus-

ception and volvulus. In a general way, the seat of the obstruction if below the ileo-cæcal valve can be determined. Forced injections beyond the ileo-cæcal valve are hardly justifiable in view of the great danger of rupturing the intestine. In rare instances manual examination by the rectum may be employed for the determination of lesions low down in the sigmoid flexure.

TREATMENT.—Surgical interference is indicated whenever an acute intestinal obstruction is suspected. When the nature of the lesion is beyond doubt the favorable period for intervention has usually passed. Surgical treatment, to be successful, must be applied in the earliest hours of the disease. The symptoms which demand exploration do not differ materially in most of the abdominal emergencies, whether the case be one of hemorrhage, of intestinal extravasation, of intestinal obstruction, or of any of the emergencies of pelvic disease. In acute abdominal lesions marked by pain, nausea, vomiting, and shock, with rigidity of the abdominal muscles, exploration is demanded. Though these symptoms may not invariably be caused by a grave lesion, in the majority of cases they are due to some mortal complication. The symptoms of later stages—distention, obstipation, stercoraceous vomiting, collapse—though they may justify interference, do not encourage it, from the mortality of operations at this stage. It is a question, indeed, whether in those cases in which death is clearly impending the surgeon's duty requires him to interfere. Nevertheless, inasmuch as a rapid exploration, with formation of an artificial anus, sometimes succeeds in these desperate conditions, exploration is probably the best course to pursue unless the patient is actually dying.

Palliative treatment in acute intestinal obstruction is justifiable only in exceptional conditions, for the mechanical causes present in the great majority of cases demand a mechanical remedy. The possible exceptions are intussusception, volvulus, and impactions low down in the intestine. By the spontaneous efforts of nature intussusceptions may be thrown off, twisted coils may be untwisted, impacted bodies may be detached. Abdominal taxis and massage in these conditions may assist spontaneous efforts at relief. In no other forms of intestinal obstruction, whether acute or chronic, do palliative measures offer reasonable hope of cure.

When *exploration* has been determined upon, the abdomen should be immediately opened—in obscure cases in the median line above or below the umbilicus, or in clear cases over the seat of the lesion. A short incision should be made at first through the peritoneum to determine, by the escape of serum, pus, fecal matter, or blood, whether some serious lesion is present. The operator, in full confidence that he is on the right track, may then enlarge the incision enough to permit manual examination of the whole abdominal cavity. The subsequent manipulations will depend upon the lesion found. Acute obstructions should be treated radically if the patient's strength justifies prolonged operation. (See Special Causes of Acute Obstruction.) If haste be essential, an artificial anus (enterostomy or colostomy), a temporary measure, may rapidly be made; radical intervention may be practised later. Bands must be divided; strangulations, intussusceptions, and twists reduced; necrotic bowel either excised or fastened into the wound and opened. The excessive distention usually present in acute obstructions and in general peritonitis seriously embarrasses both exploration and radical

operation. To relieve such distention the distended coils may be aspirated or incised.

The TREATMENT of the peritoneum after radical or palliative operation is usually that of general peritonitis. If, however, no general peritonitis be present, and if the peritoneum has escaped infection during the operation, neither general irrigation nor extensive cleansing is necessary. Indeed, both are objectionable, because they add to the shock, as well as to the danger of spreading a local contamination. (See Treatment of General Peritonitis.)

The PROGNOSIS in all forms of acute obstruction is grave; it is especially serious in those lesions attended by necrosis of the bowel-wall and general peritonitis. Obstructions due to impactions, bands, and internal strangulations are more favorable than those due to intussusception and volvulus, embolism and thrombosis. All forms of acute intestinal obstruction, relieved in the first few hours of the attack, have a prognosis by no means unfavorable. As soon as death of the bowel-wall takes place and general infection develops, the mortality under any method of treatment is excessive.

Chronic Intestinal Obstruction.—Chronic obstruction to the intestinal flow results from:

(1) The growth of tumors which involve the intestinal wall (carcinoma, sarcoma, and fibroma);

(2) Cicatrized and contracted tubercular, typhoidal, diphtheritic, dysenteric, and syphilitic ulcerations;

(3) The pressure of external growths and inflammatory masses;

(4) Fecal impactions;

(5) Ileus paralyticus of the insane.

Interference with the flow of the intestinal stream may also occur intermittently in those lesions which at times suddenly produce complete stoppage—an *intermittent* or *recurring intestinal obstruction*. This condition may occur when kinks, flexures, or bands are present, when internal incarceration exists, when a tumor growing from the internal wall becomes temporarily impacted, the impaction ceasing as soon as the intestinal spasm subsides. Chronic intestinal obstruction from organic disease in the great majority of cases is due to stricture of the intestinal lumen. Occasionally, though very rarely, the obstruction results from an outside pressure which does not involve the lumen. Organic strictures may be caused by carcinoma, tuberculosis, and benign neoplasms. The last are very unusual. They may be fibrous polyps, cysts, or lipomata. Tuberculosis of the intestinal wall is occasionally seen.

Carcinoma, by far the most common cause of organic stenosis, is situated most frequently at the sigmoid flexure; less frequently at the ileo-caecal valve and at the hepatic and splenic flexures. The disease may be annular and limited to the inner layers of the intestine, or it may penetrate early the peritoneum and involve adjacent coils. Metastasis through the lymph-channels is usually slow. The CAUSES of intestinal cancer are unknown. They probably do not differ from those of cancer elsewhere. The disease has been known to start in the cicatrices of intestinal ulcers and in the inflammatory thickenings about impacted foreign bodies.

The cancerous tumor may be a narrow ring or a broad fusiform mass

involving the internal layers only of the intestine and constricting its lumen; it may involve all the layers and contiguous coils as well. Starting from the internal surface, it may project into the lumen and fill it with a fungous and ulcerating mass (Fig. 164). The tumor may be

FIG. 164.
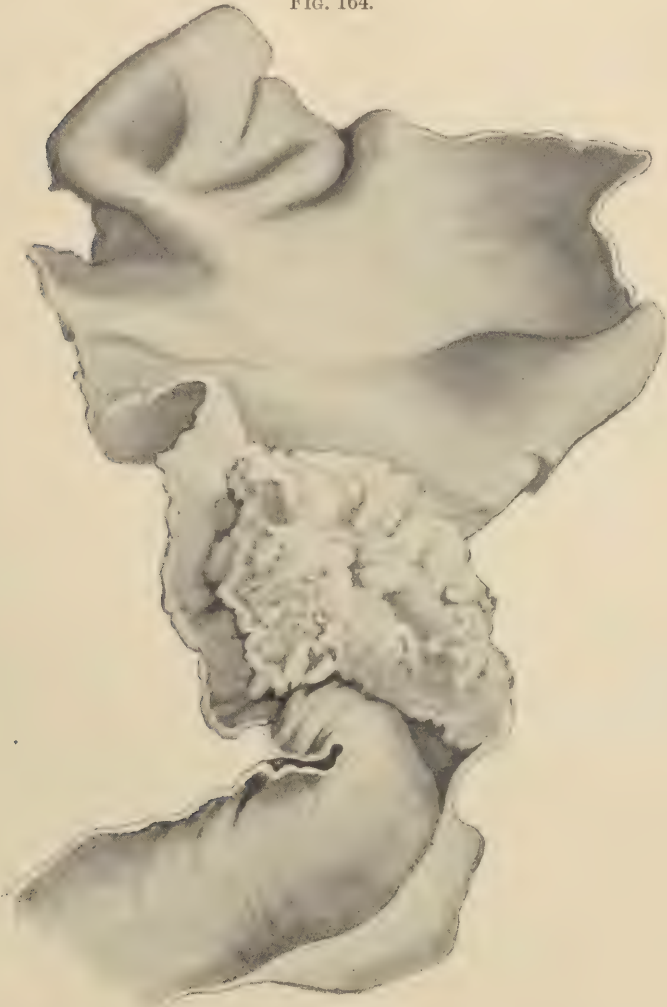
Cancer of intestine obstructing the lumen. Above the constriction the bowel is enormously dilated and its wall thickened (Warren Museum).

imperceptible by palpation or it may be conspicuous to touch and sight. In some cases the tumor cannot be felt because of its situation; in others, because of its nature. The tumor may be fusiform, oval, or flattened, smooth or irregular; of varying degrees of density, though usually hard. It may be freely movable or firmly fixed. It may be dull or tympanitic—dull if in the anterior wall; tympanitic if in the poste-

rior and covered by a distended portion of bowel. The internal surface may be ulcerated, friable, and bleeding, or projecting, smooth, and indurated. The lumen may gradually become entirely closed, and later be re-established by ulceration. As soon as the peritoneum is extensively affected serum is exuded; ascites may be excessive.

The COURSE of intestinal cancer is gradually progressive. The disease invades viscera both contiguous and remote; a general cachexia develops; death takes place from exhaustion. In other cases intestinal perforation with fecal extravasation causes general peritonitis and death. In rare instances localized peritonitis and abscess develop.

The SYMPTOMS of intestinal cancer are those of the disease itself, combined with those of obstruction, perforation, and extravasation. In the majority of cases intestinal obstruction is present; in a few, perforation and peritonitis. The symptoms of cancer of the intestine are usually unsuspected until obstruction takes place or a tumor is discovered. An occlusion almost total may have been preceded by no symptoms whatever; the impaction of a grape-seed may cause the very first symptom. Careful inquiry may show a previous loss of weight, an indefinite malaise, an occasional colic. Advanced cases show the characteristic cachexia of cancer. Pain from the growth itself is rare; from paroxysmal intestinal efforts to overcome the obstruction it is the rule. The tumor is usually tender.

The symptoms of cancerous obstructions are either acute or chronic and intermittent. The former, being dependent upon simple obstruction, are unaccompanied by the symptoms of bowel-necrosis. (For changes in the bowel-wall above constriction, and for symptoms of chronic obstruction in general, see Pathology and Symptoms of Chronic Obstruction.)

DIAGNOSIS OF CANCER OF THE INTESTINE.—Cancer of the intestine must be distinguished from benign neoplasms and from benign strictures, from lesions outside the intestine causing obstruction, and from incomplete obstruction by bands and incarcerations.

The diagnosis is generally easy. The symptoms are progressive. A gradual impairment of health and loss of weight, preceding obstructive symptoms in patients at or beyond middle life, suggest the possibility of cancer; a marked cachexia strengthens the diagnosis; a hard movable tumor, with ascites, confirms it. Yet the lesion may not be cancer. Exploration alone will decide the question. In the absence of a tumor the diagnosis must be in a measure doubtful, though obstruction in an adult preceded by loss of weight alone is sufficient evidence in the majority of cases to warrant the diagnosis.

In strictures of benign origin the health is unimpaired, cachexia is absent, the symptoms are not, as a rule, progressive. Even in cicatricial strictures and in pressure obstructions the patient lives for months or years in comparative comfort.

The TREATMENT of intestinal cancer is (1) *medical* and *palliative*—to keep up the strength (food and tonics); to allay obstruction (opiates, liquefaction of fæces); (2) *operative*—excision of the disease; end-to-end suture with anastomosis; artificial anus.

Obstructive symptoms are best allayed by opiates, which relieve spasm and proximal pressure. Small doses of opium or morphine will often produce evacua-

tions when cathartics will prevent them. Liquefaction of fæces, always present above chronic obstructions, may be augmented by the avoidance of coarse food, seeds, etc.

Whenever possible the disease should be thoroughly excised. Repair must be made according to circumstances—end-to-end suture if possible or closure of the resected ends and lateral anastomosis. (See Operations on the Intestine.)

The successes reported after complete removal early in the disease encourages the hope of permanent cure. When radical removal is impossible, lateral anastomosis should be performed. An artificial anus should be made in those rare instances only in which the proximal and distal coils cannot be brought in contact.

Sarcomata of the intestinal wall are rare, though occasionally seen. They occur at all ages, but most frequently in the young. They are usually secondary. More rapid in growth than carcinomata, they present the same symptoms. A tumor can generally be felt. Palliative and radical treatment do not differ from that of cancer, though radical removal is possible only in primary cases.

Stenoses resulting from cicatricial contractions after intestinal ulcers, tubercular, typhoidal, syphilitic, and diphtheritic, present the symptoms of gradually increasing obstruction (Fig. 165). Typhoidal and tubercular ulcers

Fig. 165.

Stricture from cicatrized tubercular ulceration (Warren Museum).

are usually situated in the small intestine; diphtheritic (dysenteric), in the large; syphilitic, at the rectum.

Cicatricial stenoses, like cancerous, may not be suspected until the lumen is extremely small. Transitory colics result from a narrowing which requires unusual peristaltic effort. The general health is unaffected. Complete obstruction may come on suddenly from impaction of a seed or other solid particles.

The TREATMENT should be radical in all cases—by excision with suture or anastomosis or by enteroplasty. Artificial anus need never be employed; anastomosis at one point or another is always possible.

External pressure from neoplasms or inflammatory masses should be suspected whenever obstructive symptoms arise in the presence of abdominal tumors and inflammatory exudations, the nature of which is obvious.

Chronic obstructions occasionally occur as the result of the *impaction of hardened fecal masses* in the ascending or the transverse colon. This

condition is most frequent in constipated old women. Fecal masses simulating hard, nodulated, and movable tumors can often be felt through the thin abdominal walls. Serious mistakes in diagnosis may occasionally be made in this condition.

Ileus paralyticus is due to the paralysis of the muscular coats of the intestine. The possible occurrence of this lesion should be borne in mind in the presence of chronic obstructive symptoms in the insane.

Fecal Fistula and Artificial Anus.

An artificial anus is an abnormal opening in any part of the abdominal wall through which all the contents of the bowel escape. The opening in the bowel is made after securing it to the abdominal wall. An intestinal fistula is an opening through which only a part of the intestinal contents escapes. Intestinal fistulæ may be external or internal. An external intestinal fistula is a direct opening from any portion of the intestine through the abdominal parietes. An internal intestinal fistula is a communication between the intestinal tract and the the bladder, the stomach, the vagina, the gall-bladder, the pleura, or the lungs, or between contiguous intestinal coils.

ETIOLOGY.—An artificial anus is practically always intentional, made for the relief of surgical emergencies or chronic obstructions. Intestinal fistulæ are always accidental, and may be caused by

(1) Penetrating and lacerated wounds and ruptures of the intestine ;
(2) Perforation of the intestine by typhoidal, syphilitic, and tubercular ulcerations, by the necrosis and gangrene of internal strangulation, by foreign bodies, and by malignant disease ;
(3) Intestinal actinomycosis ;
(4) Rupture of appendicular or other pelvic or abdominal abscesses ;
(5) Injury to the intestine in the course of abdominal operations ;
(6) The giving way of ligatures or sutures ;
(7) The pressure of drainage-tubes.

The ulcerations that most frequently terminate in intestinal fistulæ are of the tubercular variety. Foreign bodies, gall-stones, enteroliths, or fragments of bone may make their way out of the abdomen through adhesion-formation, abscess, and external perforation. Malignant disease, complicated with septic infection and suppuration, is a not uncommon cause of intestinal fistulæ. Actinomycosis occasionally results in abscess, intestinal perforation, and fistulæ: it occurs most frequently in the ileo-cæcal region. The most common causes of external and internal intestinal fistulæ are pelvic and abdominal abscesses.

The majority of intestinal fistulæ close spontaneously sooner or later. Those that may be reasonably expected to close under palliative treatment are the ones in which the opening in the bowel is small, not due to tubercular or malignant disease or actinomycosis, and in which the fistula is not lined with intestinal mucous membrane. Internal intestinal fistulæ in the majority of cases cause no symptoms.

The SURGICAL TREATMENT of intestinal fistulæ consists in—

(1) Stimulation and cauterization of the fistulous tract and free drainage of the abscess-cavity, with or without curetting ;
(2) Disinfection and suture of the fistulous tract, without opening the peritoneal cavity ;

(3) Complete excision of the fistulous tract and intestinal resection or anastomosis.

The risks in the radical operation are considerable. The mortality has been high, because of the difficulty of preventing contamination of the general peritoneal cavity. When the fistulous opening is so high up in the small intestine that the nutrition of the patient is seriously impaired operation should be performed as soon as possible. On the other hand, cases in which the nutrition is not interfered with should be treated for many months by the simpler methods before resorting to intestinal resection or anastomosis.

Closure of an artificial anus should be accomplished by complete freeing of the intestine, with resection of the fistulous opening and suture. The adherent coil should be completely separated and drawn out of the wound. The fistulous opening can then be carefully and thoroughly excised; the freed coil will permit satisfactory approximation of the refreshed edges. After suture the coil may be returned to the abdominal cavity and the external wound closed, a small strand of gauze being left for security against extravasation.

METHODS OF INTESTINAL SUTURE.

(For the history and development of intestinal suture methods the student is referred to larger works on surgery.) The correct principle of uniting intestinal wounds was not determined until 1825, when Lembert taught the necessity of approximating serous surfaces to serous. Since then a multitude of sutures and mechanical devices have been brought forward, only a few of which have stood the test of practical use. Those most used at the present time are—

(1) The Lembert suture in its different forms;
(2) Czerny-Lembert suture;
(3) Halsted's quilted suture;
(4) Cushing's right-angled suture;
(5) Senn's bone plates;
(6) The Murphy button.

The approximation of serous surfaces to serous is accomplished by passing the sutures in and out of the intestinal wall at right angles to the line of proposed union and a short distance from it (Fig. 166). The needle pierces the peritoneal, muscular, and submucous coats, but does not enter the mucous. When the needle strikes the submucosa a sudden resistance is encountered by which the layer is recognized. A narrow portion of the submucosa is caught by changing the direction of the needle, which thence is brought out of the intestinal wall, carried across to the opposite intestinal surface, where the process is repeated. Tying the sutures inverts the edges of the intestine and approximates the serous surfaces.

FIG. 166.

Diagram of Lembert suture.

(1) The *Lembert* suture may be applied either as an interrupted or a continuous stitch. (See Fig. 167.) It has the advantages of simplicity and rapidity.

(2) The *Czerny-Lembert* suture differs from the preceding in that a preliminary set of interrupted stitches is applied to the mucous membrane.

(3) *Halsted's* suture applies the Lembert principle to the plain quilted stitch.

(4) *Cushing's* right-angled suture is a continuous quilted suture.
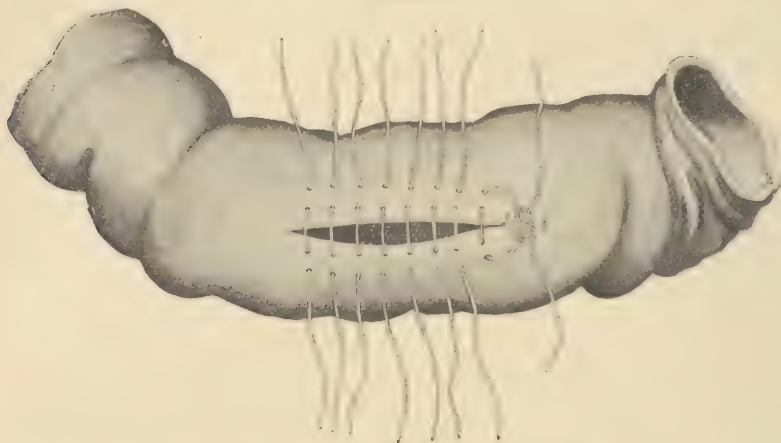
Application of the interrupted Lembert suture.

Senn's bone plates and the Murphy button are the two mechanical aids to intestinal anastomosis and suture most widely known and used.

(5) Senn's plates, composed of decalcified bone, have been used for making rapid anastomosis between hollow viscera. In the viscera to be approximated, suitable incisions are made, into which the plates are slipped. They are then fastened into position by transfixing the walls of the bowel with the needles and tying the threads. Additional interrupted stitches may be used for greater security.

(6) The Murphy button is a recent mechanical device, the construction of which will be seen in the accompanying figure (Fig. 168). It

FIG. 168.
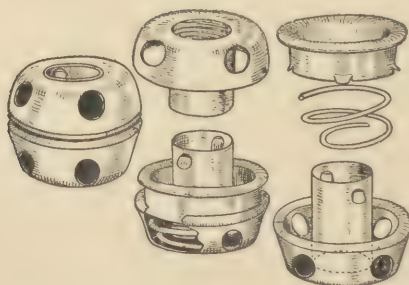
The Murphy button.

can be used with rapidity and accuracy in end-to-end union and in lateral anastomosis. The two portions of the button are first secured by purse-string sutures in the coils to be united, which are then approximated as shown in Figs. 169, 170. Union of the peritoneal surfaces

results; the button is released in from ten to twelve days by sloughing of the included tissues and passed *per anum*.

FIG. 169.
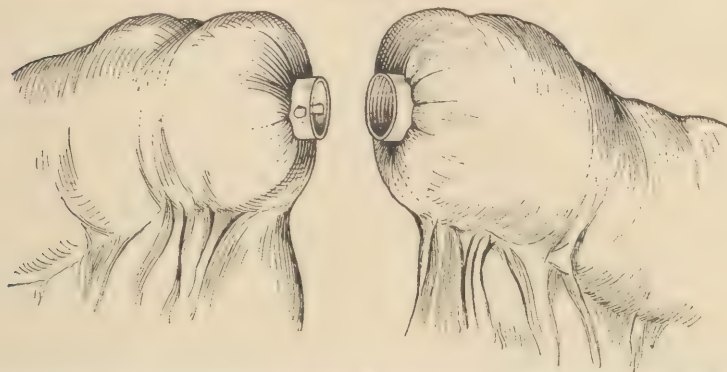
End-to-end union of intestine by means of the Murphy button: the two portions of the Murphy button, held in position by purse-string sutures, are ready to be pressed together.

Wounds of the intestine may be closed by either the Lembert, the Halsted, or the Cushing suture in a single or a double row. End-to-

FIG. 170.
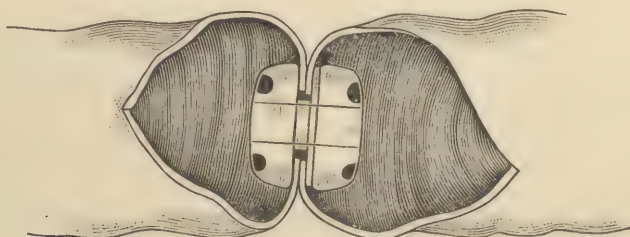
Union—end to end—with the Murphy button.

end union or lateral anastomosis may be performed by the use of sutures alone or by the aid of Senn's bone plates or the Murphy button. If time permits, union by the application of the Lembert or Halsted suture is far preferable to that by mechanical contrivances. When the condition of the patient demands speed, it is best to use either the plates or the button as may seem preferable to the individual operator. Senn's plates are used only in anastomosis; Murphy's button, in anastomosis and in end-to-end approximation.

OPERATIONS ON THE INTESTINE.

The principal operations on the intestine are—*resection, anastomosis, enterotomy, enterostomy,* and *enteroplasty*.

Intestinal resection is demanded—

(1) Whenever the vitality of the bowel is seriously impaired by injuries, internal or external strangulation, mesenteric embolism or thrombosis;

(2) In intussusception and volvulus;
(3) For restoration of the lumen in cases of benign stricture and
for extirpation of tumors and malignant disease;
(4) For the cure of fecal fistulæ.

Most of the lesions demanding resection involve the small intestine, although the seat of intussusception and volvulus is usually the large intestine.

Previous to resections of the intestine the bowel should be empty whenever possible, for manipulations are thus facilitated and the danger of fecal escape and of peritoneal infection are minimized. Excepting in acute emergencies and chronic obstructions, in which the distended bowel above the obstruction cannot be reached, the intestines may be emptied by rectal enemata and by the use of cathartics and liquid food for twenty-four or forty-eight hours before the operation. Preliminary washing out of the stomach may also be employed.

The incision through the abdominal wall should be made long enough to permit free delivery of the diseased intestinal coil. Operative manipulations should be as far as possible outside of the peritoneal cavity, which should be protected thoroughly by gauze packing. Great distention in the intestinal coil may be relieved by aspiration or by incision. (See Peritonitis.) Compression of the bowel above and below the diseased portion may be effected by the fingers of an assistant or by mechanical aids—rubber bands and clamps. Digital compression is preferable. The seat of the disease should be completely excised, the mesentery being tied in sections. *Suture of the divided bowel should begin at the mesenteric border.* It is at this point that the greatest care must be taken to make the joint tight. Excision of a V-shaped piece of mesentery may be necessary before the application of the stitches. After the mesenteric border has been thoroughly secured application of the remaining sutures may be made in any order, provided that the inverted edges are brought securely together. Any one of the methods of intestinal suture previously described may be used, according to the

Fig. 171.
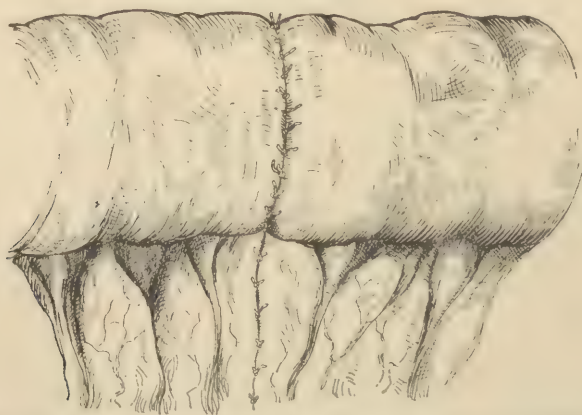
End-to-end suture after the application of interrupted Lembert stitches.

preference of the operator. The interrupted Lembert is undoubtedly the best and the one generally employed. The manner of applying the stitches and of securing the mesentery will be seen in the accompanying

diagram (Fig. 171). If time permit, a second row of interrupted sutures may be used, though in the majority of cases this procedure is not necessary for safety; moreover, by inverting too broad a margin a constricting ring may be produced in the lumen of the gut.

If the condition of the patient is such as to demand extreme rapidity in operative technique, no better method can be employed than the use of the Murphy button, as shown in the diagrams (Figs. 169, 170). Lateral anastomosis, after resection and closure of the divided ends, possesses no advantage over end-to-end union by suture. The operation cannot be done any more rapidly; peristalsis is interfered with; the course of the fecal stream is abnormal; and the lateral opening always contracts. When the condition of the patient will not permit end-to-end union by suture or even by the use of the Murphy button, an artificial anus should be made, and secondary suture performed at a subsequent and more favorable time. After intestinal resection and suture a strand of gauze should be left in contact with the line of sutures to provide against the giving way of a stitch with extravasation and peritonitis, the principal cause of death after this operation. The strand of gauze should emerge from the lower angle of the abdominal wound, and the wound itself be almost entirely closed. The gauze should be removed at the end of forty-eight hours.

Intestinal Anastomosis.—Portions of the intestinal tract more or less distant from each other may be united by lateral intestinal anastomosis, an expedient by which the intestinal stream is diverted around some obstacle to its flow. The procedure is indicated (1) in lesions of the intestine too extensive for free excision and end-to-end suture; (2)

Fig. 172.

Lateral anastomosis: first stage of the operation.

in cases demanding haste. Anastomoses between the stomach and the intestine are indicated in pyloric obstructions too extensive for resection. In the field of gastro-enterostomy the principle of lateral anastomosis is most useful; in many instances it affords the only prospect of relief.

Lateral anastomosis may be performed with sutures alone or by mechanical devices. When performed by means of sutures alone, a longitudinal cut is made, two or three inches in length, through the coils to be united. The incision should be made opposite to the mesenteric attachment (Fig. 172). The posterior edges are first brought together by means of a continuous or an interrupted stitch. The margins of the cut may be sewed over and over before uniting them. The anterior edges are next united by another continuous stitch. Finally, for additional security, a second line of interrupted or continuous sutures may be applied (Fig. 173).

Fig. 173.

Lateral anastomosis: operation finished.

The disadvantage in the use of sutures alone is the time required. The objection to the use of mechanical devices in general is the insufficient size of the anastomotic opening and the great danger of secondary contraction; to the use of the Murphy button, in particular, the danger of extravasation and of the impaction of the button itself. To prevent closure by contraction the intestinal opening should be as large as possible. Intestinal anastomosis is generally made between intestinal coils above and below a constricted portion.

Enterostomy is the formation of a permanent opening into the intestine; the term is usually restricted in its use to such operations upon the small intestine. It is an emergency operation, demanded for the temporary relief of acute intestinal obstruction; it is not to be employed if the strength of the patient justifies radical procedures. Enterostomy differs from the formation of an artificial anus only in that it usually involves the small intestine. The operation consists simply in incising the bowel after it has been sutured to the abdominal wound. The objection to the operation is that if the opening be made too high in the small intestine, the nutrition of the patient is seriously impaired. Notwithstanding this, enterostomy, even high up in the small intestine, may be successful in tiding the patient over the immediate dangers of an acute obstruction, so as to permit radical treatment of the disease later.

Jejunostomy for purposes of feeding is a form of enterostomy occasionally necessary as a substitute for gastrostomy in cases of malignant disease of the pylorus and neighboring structures so extensive that neither resection nor anastomosis is feasible. The operation has been performed but seldom. In the execution of this procedure care must be taken not to interfere with the excretion of the bile and the pancreatic juice.

Enteroplasty is an intestinal operation exactly similar in its technique to pyloroplasty. (See Operations on the Stomach.) By this procedure fibrous strictures of the intestinal wall are overcome without resection of the gut. Through the tissues of the stricture a diamond-shaped incision is made which is sutured transversely. Opportunity for such an operation seldom arises, however.

DISEASES OF THE VERMIFORM APPENDIX.

EXCLUDING possibly pelvic inflammations in the female, appendicitis in its various forms is the most common surgical affection of the abdomen. In males it is by far the most important.

ANATOMY.—The vermiform appendix is attached to the cæcum near the insertion of the ileum. The base of the appendix arises at the beginning of the longitudinal striæ of the large intestine. It is attached to the ileum by a mesentery which varies in length, breadth, and thickness. The blood-supply is from the ileo-colic branch of the superior mesenteric artery. In females a branch to the appendix from the ovarian artery occasionally furnishes an additional blood-supply—a fact which may account for the comparative infrequency of appendicular necroses in women. The base of the appendix is constant, moving with the movements of the cæcum; its extremity may point in any direction. The normal situation of the appendix, therefore, varies between extreme degrees. It depends, first, upon the position of the cæcum itself, and, secondly, upon the length and direction of the appendix. In most cases the cæcum is movable and the base of the appendix easily accessible; occasionally the cæcum is fixed deep in the iliac fossa or is turned upon itself, carrying the base of the appendix sometimes as high as the right kidney. The main body of the appendix may float among the intestines, pointing in any direction; it may be deep in the pelvis, between the rectum and the bladder or (in the female) between the rectum and the uterus; it is often retro-cæcal; not infrequently the tip is in the loin, and it has been found also in contact with the liver. The appendix is sometimes situated in a fossa of the peritoneum behind the cæcum. It has been found in extraordinary positions—in a scrotal or umbilical hernia or at the extreme left of the pelvis. These peculiarities of situation have an important bearing upon the symptoms, cause, prognosis, and even the etiology, of appendicitis.

The vermiform appendix varies in length, in weight, in calibre, and in size. Ordinarily it is about the length of the little finger; it may be six or eight inches long. It is rarely, if ever absent. It has a mucous, muscular, and peritoneal coat. The middle layer, rich in adenoid tissue, is prone to septic infection. The appendix contains numerous solitary follicles. The lumen of the appendix varies in size. Not infrequently it is constricted near the cæcum. It is sometimes considerably dilated at the tip, and the organ has a club shape. The normal appendix is smooth and glistening, pinkish in color, and generally without visible blood-vessels. It is soft; rolled between the fingers, it gives no special sense of resistance. It is freely movable in all directions, and can be bent upon itself without fracture. The most important structural fact is the great thickness of the adenoid layer. The vermiform appendix has muscular fibres and a peristalsis of its own. Vermicular action is often observed. It shrinks in length very noticeably after removal from a living subject.

ETIOLOGY.—Appendicitis is a very common disease. It occurs much

oftener in males than in females. No age is exempt from it; it has been seen in a child of two and in a man of eighty. It is seen most frequently in the early years of life. Excluding deaths from certain zymotic diseases, deaths from appendicitis exceed in number those from any other acute abdominal lesion. *It is by far the most common cause of peritonitis in the male, and it is not an uncommon cause in the female.* There are no recognized conditions predisposing to appendicitis. Though it not infrequently occurs in the course of diarrhœa, it is seen quite as frequently in persons of constipated habit. The etiology is obscure.

PATHOLOGY.—The inflammatory changes of appendicitis usually begin in ulcerations of the mucous membrane, through which micro-organisms make their way into the adenoid tissues. A necrosis ensues which may be limited in depth, length, and width; a small area may be involved or the whole organ may become gangrenous. Invasion of the peritoneum may cause a localized septic peri-appendicitis; sloughing of the necrotic area may result in perforation and extravasation. Ulceration of the mucous membrane may be caused by the pressure of fecal concretions or of foreign bodies, though foreign bodies are rarely met with. Smooth, hardened fecal masses, varying in size from that of a white bean to that of an olive, are found in the great majority of cases of gangrenous appendicitis. In some instances, however, no such cause is found. Pathological changes in the mucous membrane of the appendix are often associated with similar lesions in the mucous membrane of the cæcum, and are doubtless often dependent upon them. In a considerable number of perforative inflammations no local cause can be found. In all acute gangrenes of the appendix the afferent artery, a terminal without anastomoses, will be found thrombosed—it will not bleed when cut. In fully-established necroses the gangrenous process extends from the interior to the surface. The width of the necrotic area is generally larger on the internal than on the external layers. In many instances the process will be found limited to the mucous and adenoid layers; as a rule, however, all the layers will be found affected. Very frequently the process goes on *without symptoms until the peritoneal coat becomes involved;* hence in many cases the very first symptom is that caused by an infection of the peritoneum—an infection which varies from that of a minute bacterial invasion to a rapid and extensive fecal extravasation. The necrotic area may be situated anywhere in the appendix. (*Vide* Plate IX.)

The COURSE and the PROGNOSIS of the disease depend largely upon the exact seat and size of the perforation. As a rule, *when the perforation is situated at the tip, extravasation is slow and the peritonitis localized; when at the base, extravasation is rapid and the peritonitis general.* The rapidity of the extravasation depends also upon the size of the appendicular lumen and upon the amount and liquidity of the cæcal contents. In some instances the necrotic process is so near the cæcum that a portion of its wall is involved. This complication, though extremely rare, is as a rule rapidly fatal. Sometimes the whole appendix, with its mesentery, is gangrenous. In general as well as in limited necroses of the appendix a local and limited peritoneal infection begins as soon as the peritoneum is threatened—a general fulminating infection when the necrotic area gives way and intestinal fluids burst forth. Chronic infec-

PLATE IX.

Illustrating various degrees of involvement of Appendix Vermiformis. (Richardson.)

A. Chronic, recurring.
B. Ditto, much thickened.
C. Acute, with necrosis and rupture.

D. Showing local necrosis.
E. Gangrene and perforation permitting fæcal extravasation.
F. Total gangrene without perforation.

tious processes, limited chiefly to the mucous and adenoid layers, result in the usual catarrhal changes in the former, with more or less thickening of the latter. A general thickening, with an increase of weight, results. Such an appendix is resistant, friable, and deeply injected; it can easily be recognized by the finger. Wherever it may be situated in the abdomen, it may sometimes even be detected by palpation through the abdominal wall. The omentum in acute appendicitis, in a large proportion of cases, will be found in contact with the diseased appendix; sometimes wrapped about it. It is often thickened, reddened, and necrotic.

Cultures in acute appendicitis show almost invariably the colon bacillus alone; in appendicular abscess of long standing, a mixed infection. (See Peritonitis.) The colon bacillus is found in the peritoneum about the appendix, in the layers of the appendix itself, and in its interior. The latest observations seem to show, however, that many intestinal organisms are present in this disease.

Acute inflammations of the appendix which affect its peritoneum result almost always in peritonitis, either localized or general. The same bacteriological element probably exists in both, the difference being one of degree.

When the perforation, from its size or its position or from any other reason, causes a rapid fecal extravasation, the infection is usually general; when slow, local. In other words, the extent of the infection depends largely upon the power of the peritoneum in a given case to form barriers against spreading inflammation. In many chronic lesions of the appendix the peritoneal layer is unaffected and no adhesions whatever exist. Occasionally a long-continued though mild type of inflammation results in extensive adhesions—sometimes of cartilaginous firmness. In the so-called obliterative appendicitis the ulceration and gangrenous process result in cicatricial contractions by which the lumen is partially or entirely obliterated. Such an appendix may be contracted throughout its extent, or it may be club-shaped—cicatricial contractions separating the distal end from the cæcum. The tip under such circumstances is often distended by the secretions of a mucous surface which has no outlet—an appendicular cyst, the contents of which are often sterile from long encapsulation.

An appendix, the seat and centre of recent inflammation, of which the products have been absorbed, often contains cheesy, friable, or grumous masses. Such an appendix is easily torn by the fingers or the instruments. In the course of time such evidence of recent infection disappears and the changed tissues become the seat of firm cicatrices. Remote pathological changes after acute appendicular inflammation are seen in cords and bands, which sometimes produce in the intestines an acute obstruction. In rare instances the appendix has the usual appearance of tubercular infiltration.

SYMPTOMS.—The first and most important symptoms of appendicitis are pain and vomiting, which, in the vast majority of cases, are the only symptoms in the first few hours of the attack. The subsequent symptoms are those of a localized or of a general peritonitis. Pain usually begins in the region of the umbilicus or in the epigastrium. It is soon accompanied by tenderness, and both become localized in the right iliac fossa or wherever the appendix may be situated. The pain is at *first paroxysmal—later, constant.* The temperature and pulse rise. Chill is rarely observed in the beginning of the attack, or, in fact, at any time

during the course of the disease. The objective signs are either negative or they are those of a localized or of a general peritonitis. Sharp inflammations, not attended by extravasation, show no further symptoms than those already described. The pain and tenderness gradually subside; there is neither dulness nor tumor; the appendix can seldom be felt; the constitutional symptoms disappear; and in the course of a few days the patient is able to leave his bed. When by perforation the contents of the appendix or of the cæcum escape, the symptoms of a localized or of a general peritonitis ensue. (See Peritonitis.) *Dulness and tumor are present if the inflammation and effusion are localized and near the surface.* Such inflammations, however deeply situated, give no external signs whatever. When the lesion is deep in the pelvis, tenderness and tumor will sometimes be detected by rectal examination; when high up above the cæcum, tenderness and dulness are noticeable in the right flank; when at the usual seat of the appendix, at a point halfway between the anterior superior spine of the ilium and the umbilicus. The absence of tenderness in this definite spot by no means precludes the possibility of an appendicitis. The constitutional signs of infection gradually subside as the infection becomes limited by adhesion-formation. The physical signs of abscess become more and more pronounced as the collection of pus increases in size. A distinct tumor can be felt early in superficial cases, late in those deeply placed.

Collections of pus near the rectum often encroach upon that canal, and sometimes break into it. They can be readily detected by the finger. Localized abscesses in the flank may come in contact with the liver; they may break through the foramen of Winslow and infect the lesser omental cavity; they may extend between the liver and the diaphragm (subphrenic abscess), and may perforate the pleura, or even the lung. It is extremely rare, however, for pus to perforate the abdominal wall. Left to themselves, fecal abscesses of appendicular origin either break into the peritoneal cavity and produce an immediate and fatal general infection, or empty themselves into the intestine, the bladder, or the vagina.

DIAGNOSIS.—The diagnosis of acute appendicitis is rightly regarded as easy. Chief among the lesions to be differentiated from appendicitis are *perforations* of other portions of the alimentary canal, *internal strangulations, right-sided renal calculus, strangulation of a Meckel's diverticulum, rupture of an extra-uterine pregnancy.* In the female *inflammation of the Fallopian tubes* must be considered.

In the vast majority of cases pain and tenderness in the right iliac fossa, with local physical signs, are sufficiently diagnostic of appendicitis to justify serious consideration of operative interference. On the other hand, the signs of appendicitis may be markedly atypical and lead to error. The pain and tenderness may be remote from the usual seat of the appendix; no tumor may be perceptible; the pulse and temperature may be normal; the bowels free; in fact, the variations in the symptoms not infrequently seen in peritonitis may appear also in appendicitis.

TREATMENT.—The treatment of acute appendicitis *depends first upon the period at which the disease is recognized.* Without doubt the best treatment, could it be applied in the first hours of the disease, would be immediate exploration and removal of the appendix. Inasmuch as few cases come into the surgeon's hands so early in the disease, however, the question of operation becomes one much more difficult of solution. The rule demanding that every case of appendicitis be operated upon as soon as the diagnosis is made is not approved by the

majority of those most experienced in the treatment of the disease. It is extremely desirable to remove the appendix in the interval of health— to ease the patient, if possible, through an acute attack with an intercurrent operation in view. Certain cases justify medical treatment for this end. Whatever may have been the indications in the early hours of the disease, its probable course can usually be determined with some certainty at the end of the second, third, or fourth day, the period at which the case is usually seen by the surgeon for the first time. The infection at this time is either successfully localized or it has become general. When successfully localized, the case may be watched if the constitutional symptoms are not severe or if they are improving. Yet even in the face of an undoubted amelioration of the constitutional signs delay is not justifiable when the local symptoms are conspicuous. In many cases the temperature and the pulse fall, even in the presence of a marked tumor. Such localized collections of pus must be evacuated immediately. When the local signs are mild, or when, with the constitutional ones, they are subsiding, delay is desirable. In all cases the most careful watch should be kept of both. When both local and constitutional symptoms are severe, even if there is no evidence of a general peritoneal infection, exploration is always demanded.

Certain specific symptoms, however, in themselves demand exploration ; such, for instance, as *continued and intense pain, board-like rigidity of the muscles of the right side of the abdomen, constant vomiting,* and *high pulse, with or without increased temperature.* On the other hand, a *high temperature alone is of slight significance* as an indication for operation ; a *high pulse alone is a much more reliable guide. In cases of doubt it is safer to operate than to delay. Localized abscesses should be opened as soon as they are recognized.*

The chief objection to operating on the third and fourth day in cases that are doing fairly well—cases in which, presumably, an adhesive barrier against the extension of infection has been successfully made—lies in the danger of converting a local into a general inflammation. That this danger is great numerous observations seem to prove. Many a patient that was doing not perfectly, but fairly well, has had the scale turned against him by injudicious interference.

Operation.—The guide to the incision should be the tumor ; if none be present, the seat of greatest tenderness. In the absence of definite localizing signs the cut should be made over the usual seat of the appendix—namely, halfway between the umbilicus and the anterior superior spine of the ileum. The incision should be a long one, parallel with the fibres of the obliquus externus and across the internus and transversalis, so that clear inspection and free manipulation may be possible. In most cases *oedema of the cellular tissue* between the abdominal muscles will show that the surgeon is on the right track. The peritoneum is often so changed that it cannot be recognized. It must be incised with the greatest care, for many instances have occurred in which the knife has gone directly into the intestine. As soon as the peritoneum is opened, if there be any intra-abdominal lesion present, serum, either clear or turbid, will escape. Turbid serum generally, though not always, contains micro-organisms ; serum containing gas and fæces indicates a general fecal infection. If the peritonitis be limited, and if it must be

approached through the general cavity of the abdomen, gauze barriers against general infection should be carefully placed toward the median line on all sides of the tumor. *In cases of abscess incised through strong adhesions the operator should be content with simple drainage when the appendix is not easily accessible.* The appendix should be removed whenever it is possible to do so without infecting the abdominal cavity. In those operations in which the peritoneal cavity is necessarily opened no further harm can follow removal of the appendix itself. Separation of the appendix can generally be accomplished easily with the finger. A little experience will enable the surgeon, by the sense of touch, to detect the appendix without question, and to determine the extent and strength of the adhesions. In most cases the appendix can be easily delivered. It should be tied through its base and through its mesentery with catgut: silk becomes infected and causes a sinus which persists until it is cast off. After removal of the appendix the parts should be carefully dried with sterile gauze. If the surrounding intestines are extensively infected, irrigation with salt solution or with warm water should be employed. In local infections general irrigation is not advisable, because it may spread the micro-organisms into remote regions of the abdomen. Great attention should be given to cleansing and drying the pelvis.

If the pus-cavity be large, tubes and gauze should be used; if small and dry, gauze alone. In many instances peroxide of hydrogen seems an excellent solution to use for local irrigation. The abdominal wound may be left entirely open or the ends may be closed by one or two stitches.

The Use of Salines.—In the beginning of an attack of appendicitis salines or other cathartics should not be used, for fear of causing by an increase of peristalsis and liquefaction of intestinal contents extravasation through a possible perforation. Many cases doubtless are benefited by free exhibition of cathartics, but, on the other hand, cases are not infrequently hurried into a general infection by this means. As soon as the appendix has been secured free catharsis is certainly desirable. This may be accomplished by Epsom salts in drachm doses of the saturated solution or by minute, oft-repeated doses of calomel. Both of these cathartics may be used in connection with enemata of glycerin and salts introduced high in the rectum. (See Peritonitis.)

Chronic Appendicitis; Relapsing Appendicitis; Catarrhal Appendicitis.—Whatever may be the pathology of the various lesions included under the term *chronic appendicitis*, the symptoms are usually definite enough to permit a determination of the existing cause. The symptoms are referable directly to the appendix and indirectly to the intestinal tract.

The chief SYMPTOM is *pain in the region of the appendix*—pain either paroxysmal and intermittent or dull and constant. Local tenderness almost invariably accompanies the pain. In some instances the affection is persistent, in others intermittent; in some the attack is well defined, in others obscure. Digestive disturbances are usually present, and frequently constitute the chief symptoms. The appendicular symptoms are often attributed to indiscretion in diet. The bowels may or may not be affected. In some cases there is diarrhœa; in others, constipation. The pain is sometimes violent and paroxysmal; sometimes slight and con-

tinuous. In some cases there is fever; in others, none. In a word, there is a grumbling appendix, which causes sometimes local, sometimes remote, signs, sometimes both. As a rule, chronic appendicitis manifests itself by local signs more or less severe, with chronic digestive disarrangement and general invalidism.

TREATMENT OF CHRONIC APPENDICITIS.—*The treatment of this disease should be invariably surgical*—first, because of the disability it causes, and secondly, because of the danger of an acute, fulminating exacerbation. Moreover, the patient can never safely go beyond the reach of a surgeon. The great safety of aseptic methods removes the chief objection to the performance of appendectomy. A minor objection, the liability to hernia, is practically removed by the present methods of operating.

Indications for Removing the Vermiform Appendix in the Period of Health.—This question should be seriously considered in at least three classes of cases :

(1) After recovery without operation from one severe attack ;

(2) After numerous mild attacks ;

(3) When local symptoms exist after drainage of appendicular abscesses without removal of the appendix. In this class may be considered the removal of the appendix during the operation for hernia in the scar.

(1) After full recovery from one severe attack of appendicitis removal of the appendix should be seriously considered, because a second attack may occur and be rapidly fatal. That such a sequel may, and often does, follow is shown by pathology and by experience. Moreover, the peritoneum about the appendix, altered by the first inflammation, does not resist a spreading infection as successfully as in the first instance.

(2) The appendix should be removed in the period of health in those patients who suffer from many mild attacks, because of the pain, discomfort, and apprehension which it causes. Though the pathology in these recurring mild attacks may be entirely different from that of gangrene and perforation, the chances favor local infectious processes in appendices which are the seat of chronic changes.

(3) The appendix should be removed when local symptoms recur after the drainage of appendicular abscesses without removal of the appendix, because the abundant experience of the past few years proves that in a considerable percentage of cases serious and even fatal attacks may take place after such operation. It is clear that the appendix should not be removed in cases of localized abscess unless it can be removed without opening and infecting the peritoneal cavity ; hence many operations are performed in which the appendix is not excised. In cases treated by drainage hernia in the scar is common. In such cases the advantage of closing the hernia, and at the same time of removing the appendix, is so great as to justify recourse to operative measures when this condition exists.

In all of the foregoing conditions removal of the appendix seems a most rational procedure, in view of the dangers of recurrence, however small they may be. The patient is relieved from discomfort, disability, and pain ; he need not so regulate his life as to be within easy reach of a surgeon ; after the operation there is little if any danger of hernia, and practically no mortality. Appendectomy in the interval of health is one of the most successful and gratifying operations in all abdominal surgery. Though an occasional mistake is made in that a healthy appendix is excised, its safe removal cannot but prove a source of satisfaction to the patient.

Operation for Removal of the Appendix in the Period of Health. —The method of McBurney is by far the best. The incision, an inch or an inch and a half in length, should generally be made over the seat of tenderness, sometimes not more than halfway between the umbili-

cus and the anterior superior spine of the ilium. The fibres of the external oblique or its aponeuroses are then separated longitudinally and retracted. The fibres of the internal oblique and transversalis are next separated in a similar manner. The retractors are then so shifted as to separate these muscular bundles. The peritoneum is next opened and retracted. By digital examination the exact situation of the appendix is determined. The cæcum is carefully pulled out of the wound between the thumb and fore finger. If it slips, pieces of gauze may be used to aid in delivery. As the cæcum is pulled out it should be passed between the fingers along the longitudinal striæ toward the appendix. Non-adherent appendices will usually be delivered in this manner without exposing much of the cæcum. If the base of the appendix, even in adherent cases, can thus be brought out of the wound, the rest of the organ can usually be separated with the finger. If the adhesions are so strong as not to be easily separable in this manner, the incision should be enlarged enough for free inspection and manipulation. Violent efforts at separating adhesions should not be made through the small opening already described. In many cases the vermiform appendix may be delivered and removed through an incision not wider than the thumb-nail. Not that it is necessary always to make so short an incision; it is probably better, as a rule, to make a larger one, for it is often difficult to return the cæcum through the opening after the operation has been completed. The meso-appendix must be tied with great care. The appendix itself should be tied close to the cæcum, preferably with silk, and separated by means of the actual cautery. If this is not at hand, the stump may

FIG. 174.
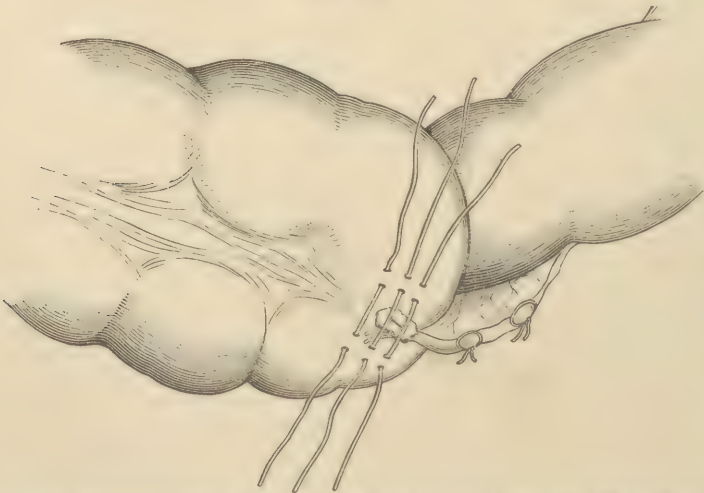
Appendectomy: the meso-appendix has been tied, the appendix removed, and the stitches are in position to bury the stump.

be treated with strong carbolic acid or with a strong solution of corrosive sublimate. When practicable, the stump of the appendix should be buried by infolding it in the cæcal wall (Fig. 174). Some surgeons make, near the base of the appendix, a cuff of peritoneum, which is

inverted and sewed over the stump. Infolding or covering the stump in the manner just described is probably unnecessary, for cases in which such a technique is impossible seem to progress equally well. In removing the appendix from its mesentery special care must be taken that the ligatures are securely tied. They should be of fine silk. The *dangers being hemorrhage and sepsis, great care must be taken to avoid both.* The abdominal wound is closed by two or three interrupted sutures. In the short incision above described one deep suture is sufficient. The mortality, in the hands of experienced operators, is probably less than 2 per cent.

SURGERY OF THE PERITONEUM.

In the consideration of surgical diseases of the abdominal viscera the peritoneum is of the utmost importance. Two of its attributes require brief attention. The first is its power of *forming adhesions ;* the second, its power of *rapid absorption.* Upon the former depend the efficient walling-off of septic foci and the success of many abdominal operations ; upon the latter, the absorption of hemorrhagic, serous, and septic exudations.

Surgery of the Peritoneum.

The formation of adhesions requires an *irritation*, mechanical, chemical, or septic, of the opposing peritoneal surfaces. The production of adhesions does not therefore necessarily require the presence of a microorganism, for aseptic surfaces scratched with a needle and approximated adhere almost immediately.

The importance of adhesive barriers in the prevention of extravasations is obvious, for example, in the lesions of gastric, duodenal, and intestinal ulcer and in perforations of the vermiform appendix.

The vast powers of absorption possessed by the peritoneum exert a powerful influence in widely different directions. It absorbs benign exudations into the general circulation with extreme rapidity ; it absorbs with equal rapidity the ptomaïnes of bacterial growth. This attribute explains the early and profound systemic depression of general peritonitis, and upon it rests the theory of the saline treatment of peritoneal infection—a treatment by which intestinal drainage is supposed to remove the toxic products of germ-growth as fast as the peritoneum absorbs them.

The peritoneum with its great extent of surface and its enormous powers of exudation presents a fertile medium for the growth of germ colonies—colonies which reproduce themselves with deplorable rapidity, luxuriance, and virulence.

Peritonitis, by far the most important affection of the abdominal cavity, is a disease which is wholly and absolutely dependent upon microorganisms. Aseptic peritonitis does not exist under the modern definition of the term, though it may be impossible by any known method of culture-staining always to demonstrate the presence of the causative germ. The extent and virulence of peritonitis are undoubtedly influenced largely by the growth, the reproduction, and the absorption of the micro-organisms present. Though it is as yet impossible to classify the varying forms of peritoneal inflammation at present described under the broad term *peritonitis*, it is not without strong probability that a bacteriological classification will eventually be adopted.

The causes of peritonitis through which micro-organisms are introduced into the peritoneal cavity are—(1) *Extravasations from the alimentary canal*—the stomach, the intestines, and the vermiform appendix; from other *septic hollow viscera*—the gall- and urinary bladders, the pelvis of the kidney; from the *genital organs of the female* through the uterus and tubes; from the *rupture of abscesses.* (2) *Intra-abdominal necroses*, which, though less common than the first group, include many of the gravest possible abdominal emergencies : (*a*) internal strangulation; (*b*) intussusception; (*c*) volvulus; (*d*) embolism and thrombosis of the mesenteric vessels; (*e*) gangrenous pancreatitis, gangrenous splenitis; (*f*) fat-necrosis; (*g*) ovarian and other tumors with twisted pedicle; (*h*) movable kidney and wandering spleen with twisted pedicle. (3) *Contamination by septic materials*, missiles, instruments, and fingers. (4) *Infections conveyed to the peritoneum*, through the circulation, from remote foci : (*a*) rheumatic, gonorrhœal, and syphilitic peritonitis, in which the direct communication between the original disease and the infection has not as yet been clearly demonstrated, and in which septic peritonitis is favored by the low state of the system in these diseases. (5) The so-called chemical peritonitis, dependent upon the irritation of chemical solutions, should not be included under the term peritonitis unless it is associated with the presence of a micro-organism.

The pathological condition may be described as an intense local inflammation, with constitutional absorption.

In the first hours of the infection, during which the lesion is now so often demonstrated, the gross appearances of the peritoneum are little if at all changed. Dilatation of the blood-vessels produces general deepening of the color. A clear serous exudation results from the initial congestion. The enormous reproduction of germ colonies in the peritoneum itself produces here and there broad flakes of lymph intimately connected with the intestinal wall. The serous exudate, holding suspended germs in vast numbers, becomes turbid. When the infection is at its height the peritoneum is everywhere intensely congested, especially over the small intestine; the color is deepened, the muscular contractions enfeebled, and the intestine finally paralyzed and distended. Easily-separated adhesions form between contiguous surfaces. Upon the distended coils, here and there, dark blotches appear; the intestinal wall is thickened; its peritoneum opaque. As the infection progresses the number and extent of the lymph-flakes increase, becoming occasionally detached and floating in the dependent serum. The distention of the intestinal wall from gas-formation becomes excessive. The serum from being turbid may become opaque, green, greenish yellow, yellow, hemorrhagic; from being thin and watery it may become thick, creamy, or grumous. In extravasations from the alimentary canal the exudate is always foul-smelling and generally contains gas.

If the patient survives the advanced stages of this infection, the congestion and thickening of the intestinal wall increase to a marked degree. The exudation becomes distinctly purulent and bathes everywhere the abdominal viscera. Beyond this stage practically all infections are from a comparatively mild germ. The gross appearances now become those of abscess. General peritoneal abscess is rarely demonstrated during life, though it is not infrequently found at autopsies. The whole peritoneal cavity may consist of a single collection of pus, or limited foci, surrounded by adhesions, may be scattered throughout the whole peritoneal space.

The *appearances of local peritonitis*, which every surgeon has abundant opportunities of observing, do not differ materially from those of the general form except in extent. The congestion and thickening of the peritoneal wall is excessive; the adhesions are strong; the lymph-deposit general throughout the localized cavity. The results of infection are prominent in the omentum, which has a special proclivity for wrapping itself about contaminated areas. The omentum becomes excessively thickened, congested, and discolored; the portion in contact with the exudation is covered with a yellowish-green lymph. In places it seems gangrenous. A true gangrenous process, however, rarely results from bacterial invasion unless there is also strangulation, thrombosis, and embolism. The lymph-flakes can always be easily removed, leaving an area of intense congestion and induration. The tumor or cake of a localized peritonitis, especially exemplified in inflamma-

tion about the vermiform appendix, is due largely to the great thickening of the adherent omentum.

The *bacteriology of peritonitis* is of the utmost interest and importance. No case should be recorded as one of peritonitis in which the diagnosis does not rest upon an expert bacteriological examination. The bacterial forms which exert the most frequent and powerful influences, according to our present knowledge, are the *bacillus coli communis* and the *streptococcus*. Less rapid and virulent, though unfortunately fatal, micro-organisms are the various *staphylococci*, the *pneumococcus*, etc. The influence of the gonococcus is as yet undetermined. In the peritonitis of intestinal extravasations the *bacillus coli communis*, usually found in pure cultures, is doubtless associated with many other forms of intestinal bacteria, which are masked by the luxuriance and rapidity of growth characteristic of the colon bacillus. In fecal extravasations gas-forming bacteria are almost invariably present. (*Vide* Chapter III. Vol. I.)

Differentiation by gross appearances between the various forms of bacterial infection is impossible, for they are not characteristic. Indeed, cases have occurred presenting the typical gross signs of peritonitis in which cultures have remained sterile.

The *colon bacillus* has been observed chiefly in appendicitis. Its malign influence in peritonitis may have been overrated, for pure cultures have been injected into the peritoneum of guinea-pigs without bad results. The fulminating variety of peritonitis, if not dependent upon the colon bacillus, must be caused by a germ of extreme virulence like the streptococcus, which is masked by the rapid growth of the former. In long-standing abscesses of appendicular origin a mixed infection is often found containing a variety of pathogenic micro-organisms.

Streptococcus infections pursue a most virulent course. They usually proceed from the uterus and tubes. Infections from the hands or from the instruments are often of this variety. The pathogenic staphylococci are introduced through various channels. Their course is less fulminating, though usually fatal. The cases which are cured by drainage are probably of this variety. The influence of the pneumococcus is little understood; that of the gonococcus, not at all. All cases of gonorrhœal peritonitis, so far as known, have been mixed infections.

Doubtless other germs, as yet undescribed, have an important bearing upon the course and prognosis of peritonitis. Yet it has been frequently observed (Massachusetts General Hospital) that in cases presenting the history and gross signs of general peritoneal infection recovery follows, as a rule, *if the cultures from the serous exudate are sterile* on ordinary media (agar and blood-serum). (See Appendicitis.)

SYMPTOMS.—From what has been said above, it is obvious that the symptoms of general peritoneal infections must vary between extreme limits. Yet certain cardinal symptoms are almost invariably present. They are *pain, tenderness, vomiting, shock; rigidity of the abdomen,* followed by *distention; constipation, fever, systemic depression, collapse. Pain* is usually the earliest symptom of peritonitis, though it may be absent; it is at first local, later general. In local peritonitis, as exemplified in appendicitis, it is often first general; later, local. It may be sharp (extravasation), paroxysmal (colic), or dull. In the later stages the pain may subside or disappear. *Tenderness* is almost always present. It varies in degree and in extent; is often local, becoming general, or general, becoming local; it may be exquisite or it may be noticeable only on deep pressure. It is a better guide to the causative lesion than pain, being more definitely referred. *Rigidity* from reflex spasm of the abdominal muscles, a symptom of the greatest importance, is always present in rapid extravasations. Rigidity points more definitely to a serious internal lesion than any other one symptom. Nothing less grave than a lesion threatening life itself can account for this symptom when it is associated with pain, tenderness, and shock.

Distention follows rigidity as soon as the infection, through intestinal

paresis, causes stasis of the intestinal stream. The intestines are often distended to an excessive degree. Obstipation and cessation of internal sounds are coincident with distention from the same causes. *Vomiting* is an early symptom in peritonitis; at times the very first. The vomitus consists in the beginning of the contents of the stomach; later it becomes green, then dark or *fecal*. In some instances it is the only conspicuous symptom throughout the disease, the patient dying of exhaustion, without pain, tenderness, fever, or distention. The signs of constitutional infection are also perplexingly various. At times the *temperature rises* rapidly to 104° or 105° or more; stays there or rapidly falls; at times it is practically normal, at times moderately elevated.

The *pulse* is more constantly affected than the temperature, rising rapidly or slowly, but continuously. In the rarest instances it may remain normal or but slightly elevated until the infection is fully developed and hopeless. The pulse, better than the temperature, indicates the patient's true condition. A temperature falling to normal or subnormal, with a rising pulse, is a combination of the gravest import. The *facies* of peritonitis is characteristic. The eyes are hollow and the cheeks dark red.

The *systemic depression* of peritonitis is always grave. In some instances the initial shock is profound. With the progress of the disease depression becomes extreme and the patient dies in collapse. The usual symptoms are present in the shock and collapse of peritonitis. The enfeebled state of the circulation shows itself not only in a rapid and weak pulse, but in cold extremities and in lividity of the skin of the abdominal wall; the latter symptom, however, may be present when the patient's general condition is fairly good. Combined with rigidity, abdominal lividity, as shown by the slow disappearance of finger-marks, is a grave symptom.

In the early stages, when operative interference is advisable and not without hope, the symptoms may be grouped as follows:

  (1) Pain general, becoming local; or local, becoming general, according to cause;
  (2) Tenderness, general, becoming local; or local, becoming general;
  (3) Rigidity of the abdominal muscles;
  (4) Vomiting, green;
  (5) Rise of pulse and temperature;
  (6) Shock, varying in depth;
  (7) Diminished peristalsis.

In fully-developed peritonitis, in which the wisdom of interference is questionable, the symptoms are—

  (1) Pain lessened or absent;
  (2) Tenderness general;
  (3) Distention excessive, replacing rigidity;
  (4) Vomiting excessive, dark or fecal;
  (5) Obstipation; peristaltic movements not heard;
  (6) Rapid and feeble pulse;
  (7) High or low temperature;
  (8) Lividity of abdominal skin; cold extremities;
  (9) Peritoneal facies;
  (10) Mind clear.

In hopeless cases the above symptoms are increased with collapse; the patient is moribund.

The DIAGNOSIS of general peritonitis is usually easy. The diseases most likely to be confounded with it are *peritoneal hemorrhage* and *acute intestinal obstruction*. It is not always possible to make a diagnosis without exploration. Abdominal hemorrhage, particularly of the extra-uterine variety, begins with sharp pain, is accompanied by shock and systemic depression, and is not infrequently attended by marked constitutional symptoms. The symptoms of *ruptured ectopic gestation* are usually accompanied by one or more signs of pregnancy. When the signs of hemorrhage are present no confusion is likely to ensue ; errors may nevertheless arise, for many cases of hemorrhage simulate general peritonitis, without being extensive enough to cause faintness. The diagnosis between general infection and acute obstructions is also at times difficult, if not impossible. (See Acute Intestinal Obstructions.)

Acute abdominal symptoms demanding exploration are always conspicuous, whatever the cause may be that produces them. In cases of doubt it is the part of wisdom to explore.

The TREATMENT of peritonitis may be *medical*—*i. e.* opium to prevent peristalsis or cathartics to increase it ; or *surgical*—irrigation and drainage. In the vast majority of cases, however, all methods fail.

Medical treatment should not be dismissed with a word, for it is better adapted to many cases than surgical. Cathartics, salines or others, are indicated at the beginning of the invasion, when the disease is feared rather than recognized, and before vomiting is frequent or excessive. On theoretical grounds intestinal drainage by means of excessive liquid stools may remove so effectually the peritoneal exudate as to absorb the infection. If the truth were known, however, it would doubtless appear that in many cases no real infection was present or even impending. The absolute futility of cathartics in advanced cases of demonstrated peritonitis lends confirmation to this statement. Nevertheless, free watery evacuations undoubtedly encourage the elimination of ptomaïnes. Saline cathartics should be used only in the early stages when vomiting is not excessive. Calomel in small, divided doses, one-fifth of a grain every hour, will at times produce satisfactory discharges.

Cathartics should never be used when intestinal perforations are suspected, for fear of increasing the extravasation. Opium should not be used unless absolutely necessary. It is indispensable in those cases in which the pain cannot be borne, and in which the harm it may do is more than offset by the relief it affords the patient.

The **surgical treatment of peritonitis** consists (1) in the *removal of the cause,* and (2) in the *removal of its effects.* (The treatment of the various causes is described elsewhere.) The second indication requires *incision, irrigation,* or *cleansing* and *drainage.* The incision must be in the median line. Its extent and situation will depend upon the cause of the infection.

The median incision should be made below the umbilicus. As soon as the peritoneum is nicked serum will escape. The appearance of the serum may indicate in a general way the nature of the infection. If clear, turbid, or purulent, without odor, the infection does not depend upon the alimentary canal ; if foul-smelling and fecal, it comes from the intestinal tract, or, rarely, the tubes ; if urinous, from the genito-urinary tract ; if hemorrhagic, without sepsis, there is mistaken diagnosis. The escape of fluid of one kind or another justifies the exploration and indicates its further prosecution. The incision should be enlarged and the fluid in the dependent portions of the abdominal cavity removed as

thoroughly as possible by means of gauze or sponges. The exploration should then proceed according to the circumstances of the case. (See Special Causes of Peritonitis.)

During the exploration, folds of gauze placed deep in the pelvis will suck out large quantities of fluid and facilitate the final cleansing. The local lesion having been repaired or removed, the whole abdominal cavity should be inundated with sterile solutions—preferably the normal salt solution—which may be introduced by means of a funnel and rubber tubing through a blunt-pointed nozzle either of glass or of metal. When the irrigation is deemed sufficient, the fluid should be removed by means of dry sterile gauze or of sterile sponges applied deep in the pelvis and the flanks. Drainage is best accomplished by means of gauze wicks, with or without drainage-tubes. The tubes and the wicks should lead from the abdominal incision into each flank and into the pelvis. Drainage may be facilitated by incision through the flanks and out of the back. The value of antiseptic solutions for irrigation is questionable, though many use corrosive sublimate, 1 : 20,000, peroxide of hydrogen or boracic acid.

The manipulations described above are seriously interfered with when distention is excessive or even moderate ; the intestines escape from the wound the moment pressure upon them is relaxed. Under excessive intra-abdominal pressure it is practically impossible to bring the irrigating fluid thoroughly in contact with the diseased coils unless evisceration is complete—a procedure which adds greatly to the shock and which is not infrequently the immediate cause of death. To empty the distended coils and to relieve distention aspiration and free incision have been practised. The latter is of doubtful utility, because a single incision will empty but a single coil. The multiple incisions necessary—all requiring suture—accomplish too little in the relief of distention to make them of much practical value. A single coil when opened may be fastened to the external wound for a temporary anus. As a rule, no considerable nor lasting effect follows either enterotomy or artificial anus.

Acute general peritonitis, when fully developed, presents almost insuperable obstacles to effective drainage. The colonies of micro-organisms make their way into the remotest recesses of the abdominal cavity, which, shut off by immediate adhesions, cannot be efficiently drained. General peritoneal infections, for this reason alone, must be fatal in the vast majority of cases under any method of treatment at present known.

The *after-treatment* requires stimulation and rectal feeding. If it be possible by the use of salines to start up peristalsis without further increasing the systemic depression, salines, though often nauseating, should be used. Peristalsis can sometimes be stimulated by the use of high rectal enemata containing powdered aloes gr. xxx, Epsom salts ℥j, glycerin ℥ij, water Oj.

The prognosis in general peritonitis after operation depends, first, upon the nature of the micro-organisms and, secondly, upon the stage of the infection. In estimating the mortality we must repeat our conviction that no cases are worthy of record in which an expert bacteriological examination has not been made.

The writer's experience in general peritoneal infections of an advanced stage is so discouraging that he welcomes statistics that go to show that even 5 or 10 per cent. recover. Some of the more recently reported results after operation vary so extremely that the conviction is irresistible that different writers, in giving their successes or their failures, are not describing the same conditions. When cases in one community are always fatal, no matter how or by whom treated, while those in another show a large number of recoveries, presumption is raised that reporters are not discussing the same conditions. No disease affecting the abdominal cavity offers a richer field for investigation than peritonitis.

Tubercular Peritonitis.

Tubercle bacilli may reach the peritoneum from the genito-urinary or intestinal tract, from the mesenteric nodes or by way of the circulation, from any tubercular focus, or in the course of a general acute miliary tuberculosis. In males the usual source of infection is the intestinal tract—more rarely the genito-urinary; in females, the reproductive organs. In children the mesenteric nodes are primarily affected by direct inoculation through the intestinal mucous membrane.

The disease manifests itself in three forms : (*a*) The ascitic form—tubercular ascites ; (*b*) the dry fibrino-plastic form—adhesive tubercular peritonitis ; and (*c*) the ulcerative or suppurative form.

(*a*) In tubercular ascites the peritoneum is studded with minute tubercles throughout its whole extent or in a definitely localized region. This form of tubercular peritonitis is always accompanied by a serous exudation. If the process is general and unconfined by intestinal adhesions to one or more localities, the exudation will be encysted and moderate. Several collections of encysted fluid may be present.

(*b*) In the dry adhesive variety there is no serum ; fibrin glues the intestines together in a closely adherent mass.

(*c*) The caseous ulcerative and suppurative forms of the disease are but steps in the retrograde necrotic processes seen in all forms of tubercular disease. In this form ulceration and perforation of the bowel and the formation of internal fistulæ frequently take place. The intestines may be extensively attached to each other and to the abdominal wall by adhesions which enclose numerous collections of pus and caseous material.

SYMPTOMS.—The symptoms of tubercular peritonitis are usually vague. There is generally malaise and emaciation, variable hectic fever, gastro-intestinal disorders, diarrhœa, and occasionally pain and tenderness in the abdomen.

In the ascitic form abdominal distention develops rapidly and calls attention to the disease. In the adhesive variety the symptoms are obscure. From the matting together of the omentum and intestinal coils the abdominal condition may simulate on palpation any form of intra-abdominal tumor. In the encysted form tubercular peritonitis may be mistaken for hydronephrosis, dilated gall-bladder, cysts of the omentum, mesentery, or spleen. The adhesive variety may closely simulate malignant disease.

In the ulcerative form the constitutional symptoms are more extreme, the fever more constant and severe, and the abdominal tenderness more marked. Cases of emaciation and malaise attended by vague gastro-intestinal symptoms and variable fever should be investigated closely, for these symptoms always suggest the presence of tubercular peritonitis. Cases of the general ascitic form have not infrequently been mistaken for ovarian cysts.

TREATMENT may be palliative or operative. Operative measures are demanded in all cases in which the presence of advanced tubercular disease in other organs does not offer contraindication. Palliative measures do not differ from the medical treatment of all tubercular processes. Ascitic distention may be relieved by occasional aspiration.

Surgical treatment consists in incision and free evacuation of the fluid, with or without prolonged drainage. The fluid should be removed as thoroughly as possible by median incision below the umbilicus.

Additional drainage may be established by incision through the flanks. A single incision, with thorough evacuation of the serous exudate and immediate closure, is followed by quite as good results as prolonged drainage by means of gauze and tubes. Moreover, prolonged drainage by those means may be followed by a persistent sinus or a fecal fistula.

Care must be taken not to open adherent bowel in making the incision through the abdominal wall.

The ascitic form is the one most favorable for operation, the ulcerative form the least. Statistics show 35 per cent. of cures after operation in the ascitic form of the disease. Operation is most successful in children and young adults.

The clinical resemblance between simple fibrous peritonitis (peritonitis nodosa), cancerous peritonitis, and tubercular ascites is so close that a positive diagnosis of tubercular peritonitis with ascites requires an expert microscopic examination of one or more tubercles or nodes.

PERFORATIONS OF TYPHOID ULCERS.

Surgical treatment in typhoid ulcers is applicable to between 6 and 7 per cent. of the cases which result in perforation. From the nature

FIG. 175.
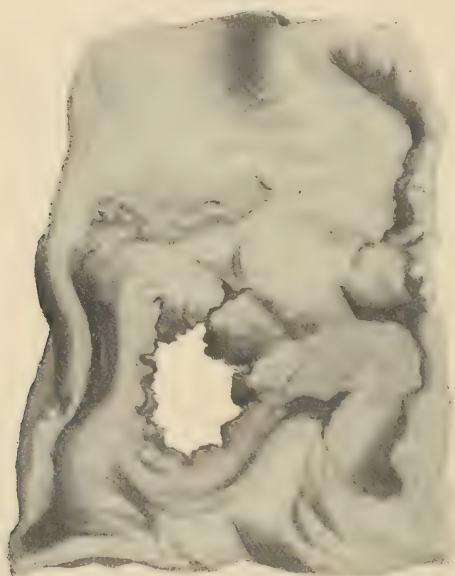
Extensive perforation from ulceration of Peyer's patch in typhoid fever in the third week (Warren Museum).

of the constitutional disease, from the extreme rapidity with which the peritoneum becomes infected by intestinal extravasation, from the dangers incident to the operation itself, the chances of saving any considerable number of cases are extremely small; yet in 23 reported operations there were 7 recoveries—a record which is better than could reasonably have been expected.

The pathological process by which perforations take place differs but little from the slower course of gastric, duodenal, or intestinal ulcers. As the ulceration approaches the serous coat the peritoneum becomes inflamed and adherent to continuous coils and viscera. In some instances these barriers result in the formation of intestinal fistulæ; in others they are insufficient to prevent a general extravasation. Slight extravasations may cause only localized abscesses; extensive ones, fulminating infections.

The surgery in general of typhoidal ulcers is that of general peritoneal infection or of localized abscesses.

The SYMPTOMS of perforation of typhoidal ulcers are those of intestinal perforations from other causes—an aggravated general peritonitis with the symptoms of the already existing constitutional disease. When in the course of a typhoid fever, mild or severe, the patient is seized with intense pain, followed by tenderness, abdominal rigidity, distention, and shock, the perforation of a typhoidal ulcer is almost beyond question. Most cases go on to a fatal termination in the course of a few hours.

Unless the collapse is extreme, the TREATMENT demanded is immediate exploration. The incision should be made in the median line, and the exact seat of the lesion determined. If but one perforation exists, the bowel may be infolded and sutured, as in the operative treatment of stomach ulcers. If the disease be too extensive to permit this method, the coil may be resected or it may be fastened temporarily into the wound. In case these methods are impracticable, gauze may be packed about the seat of perforation and brought out of the abdominal wound. The coexistent peritonitis should be treated like peritonitis from other causes. Abscesses require irrigation and drainage.

SURGERY OF THE OMENTUM.

(For Wounds and Ruptures of the Omentum see section on Abdominal Injuries.)

Abscess of the omentum is a form of localized peritonitis. It may be due to septic infection after wounds or ruptures, or to extension from neighboring viscera, most frequently from the perforated appendix.

The extraordinary capacity of the omentum for forming adhesive barriers against septic processes—extravasations and abscesses—not infrequently results in infection of the omentum itself with single or multiple abscesses.

The DIAGNOSIS and TREATMENT of omental abscesses are those of any local peritonitis with abscess-formation.

New Growths of the Omentum.—*Cysts* of the omentum may be *serous, hemorrhagic, hydatid,* or *lymphatic.*

Serous cysts of the omentum are generally of inflammatory origin. *Blood-cysts* have occasionally resulted from wounds or ruptures. *Large multilocular lymph-cysts* of the omentum are probably of congenital origin and due to dilatation of the lymph-channels. *Hydatid cysts of the omentum* are never primary. The so-called dermoid omental cysts have generally been found to be ovarian in origin. A *cavernous angeioma* of the omentum has recently been removed by Homans.

Solid tumors of the omentum may be *sarcomata, carcinomata, fibromata,* or *lipomata.* *Carcinoma* is never primary in the omentum.

Infiltrations of the omentum secondary to cancer of other abdominal structures, and of the breast, are not uncommon. *Sarcoma* has been observed as a primary omental growth. In the fibro-cystic form it has been mistaken for a simple cyst. Fibroid and fatty tumors of the omentum are very rare.

The omentum is involved in general *peritoneal tuberculosis* and in acute *miliary tuberculosis*.

DIAGNOSIS.—Omental tumors are seldom correctly diagnosticated before operations. Theoretically, a small, non-adherent omental tumor may be moved *upward* and *laterally*, but *not downward*, and will not move with respiration. It will appear superficial to inflated intestines or stomach. Large and extensively adherent tumors can only with difficulty be differentiated from other abdominal growths. Tumors confined to the omentum are not associated with functional disturbances, and are usually undiscovered until large enough to cause pressure-symptoms.

Cysts of the omentum are often confused with ovarian cysts. Aspiration may be the only means of determining the cystic nature of an omental growth.

Extensive adhesions and matting together of the omentum and intestines may simulate almost any form of intra-abdominal tumor.

TREATMENT of omental tumors should invariably consist in exploratory laparotomy with extirpation of the growth. Cysts which cannot be completely removed should be treated by incision and drainage.

DISEASES OF THE MESENTERY.

The mesentery is the seat of lesions, acute and chronic, which are at times of the greatest surgical importance. Prominent among them is *tuberculosis of the lymph-nodes* of the mesentery. This disease is associated with tubercular peritonitis, and is often a part of the disease. Occasionally, however, the lymph-nodes of the mesentery are alone infected; indeed, the infection may be limited to the mesentery of a single coil. A tuberculosis thus limited is of the deepest surgical interest, for free dissection may remove a focus of infection so close to the general lymph-reservoirs as to threaten life. Early and thorough removal of lymph-nodes thus affected may render tabes mesenterica a less formidable disease.

The SYMPTOMS of mesenteric tuberculosis are those of peritoneal tuberculosis. A limited infection with enlargement of the lymph-nodes may cause a definite localized tumor, the nature of which can only be suspected.

The TREATMENT is that of tubercular peritonitis when the infection is extensive; when localized as a distinct tumor thorough extirpation is demanded.

Mesenteric Embolism and Thrombosis.—Plugging of the mesenteric vessels is probably more common than is usually supposed. Many cases of intestinal necrosis doubtless are dependent upon this lesion. The causes of embolism and thrombosis are similar to the causes of these lesions in vessels elsewhere. The results are most disastrous, for with the stasis of circulation necrotic changes in the intestine immediately

appear. Death is sure to follow unless the affected coil is resected at once, or at least isolated by gauze barriers and opened in the abdominal wound.

The SYMPTOMS are at first indefinite. Pain is an early and prominent symptom; later appear the signs first of intestinal obstruction, and then of gangrene. Excision of the gangrenous coil before a general infection takes place offers a chance of permanent cure, as in Elliot's case.

Cysts of the mesentery are similar in origin, causes, symptoms, and treatment to cysts of the omentum (Fig. 176).

FIG. 176.
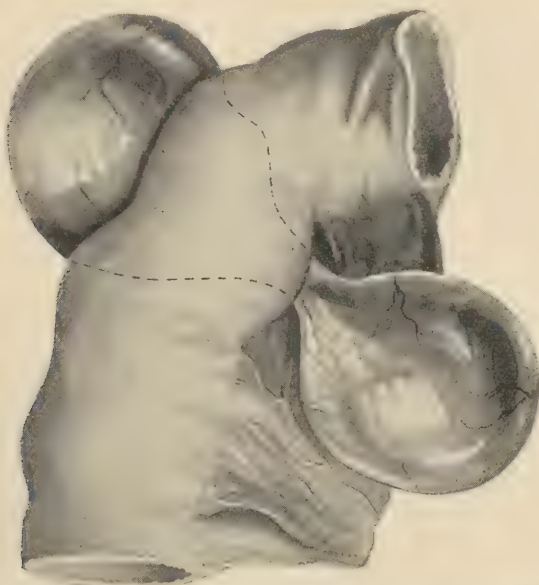
Cyst of the mesentery, containing clear fluid. The hour-glass constriction passes through the layers of the mesentery (from a case occurring in the author's practice).

PANCREAS.

(Wounds and Injuries of the Pancreas are considered on page 341.)

Pancreatitis may be either acute or chronic. The acute varieties are—

Acute hemorrhagic pancreatitis;

Acute suppurative pancreatitis;

Acute gangrenous pancreatitis.

Acute hemorrhagic pancreatitis is of surgical interest, because often mistaken for acute perforative peritonitis or acute intestinal obstruction. Operations worse than useless have been performed under such erroneous diagnoses. Its onset is sudden, its course rapid and severe, its end almost universally fatal. Those cases that survive the first day or two of the disease and result in pus-formation may possibly recover after drainage.

Acute suppurative pancreatitis or **abscess of the pancreas** is the result of invasion of any part of the gland by micro-organisms. Calculi, intestinal round-worms in the pancreatic duct, wounds, injuries, and cysts of the pancreas are predisposing causes. The septic process may extend to the pancreas from neighboring organs, especially from ulcers of the stomach or the duodenum.

Suppuration may be manifested as a *peripancreatitis*, as a *retroperitoneal abscess*, or as *multiple collections* of pus disseminated throughout the pancreas. Multiple abscesses may degenerate into one large abscess-cavity, which may communicate with the duodenum or rupture into the general peritoneal cavity. The majority of cases of multiple abscess occur in adults under forty.

SYMPTOMS.—The symptoms in nearly every case point at first to the stomach or the liver. Fever is not constant ; jaundice may exist ; the urine may contain sugar. Ascites and œdema have been present in many cases.

DIAGNOSIS.—In most of the cases of suppurative pancreatitis the diagnosis has not been made before death. Emaciation, general malaise, and gastric disturbances, with variable symptoms of constitutional sepsis, suggest the possibility of the disease. A tumor in the region of the pancreas confirms the diagnosis. To determine the situation of the tumor with reference to the stomach the latter may be inflated. The tumor may be in the epigastrium or in the right or left hypochondrium ; it may be observed in the first few days of the disease, or not for several weeks after the first symptom.

The PROGNOSIS is grave. Death is caused by acute sepsis or by progressive exhaustion. In most cases it occurs within a few days of the onset of the disease. Sudden death may be caused by rupture of abscess into the general peritoneal cavity. In rare cases rupture into the intestinal tract has resulted in spontaneous cure.

TREATMENT.—Surgical interference in suppurative inflammations of the pancreas is indicated when the signs of pus are clear. Incision and drainage are demanded. Interference in the acute stage is contraindicated. The chief care in the operation should be to prevent contamination of the general peritoneal cavity. Incision should be made in the median line, between the umbilicus and the ensiform cartilage, over the most prominent portion of the tumor. The stomach and transverse colon usually overlie the abscess and must be avoided. The layers of the omentum must be incised or torn to gain access to the pancreatic space. The general peritoneal cavity must be protected thoroughly by gauze. To establish the diagnosis the tumor may be *explored* with an aspirating needle before incision. If pus is found, the greater part of it should be drawn off through the needle, as in this way subsequent manipulations are facilitated and the danger of general peritoneal infection is lessened. A free incision into the abscess should then be made and the cavity should be thoroughly irrigated. Drainage by means of gauze and drainage-tubes will be necessary, and must be continued as long as there is any discharge. Closure of the wound after too early a removal of the tubes will result in reaccumulation of the pus. Hemorrhage from the abscess-cavity may be checked by gauze-packing. In some cases pus, starting from the pancreas and burrowing behind the

peritoneum, will make its appearance as a fluctuating tumor in the flank. Such cases should be incised and drained from behind.

Gangrene of the pancreas is the result of acute septic infection of the gland. The infection is usually of such virulence that surgical measures, to be of any use, must be applied at the earliest moment. Theoretically, there is no reason why a gangrenous pancreas should not be drained or the gangrenous portion removed. In rare cases spontaneous cure has taken place by the sloughing of the necrosed gland into the intestine.

Chronic pancreatitis or sclerosis of the pancreas is a form of chronic inflammation resulting in an increase of the connective tissue of the gland. The process may affect the whole organ.

In the early stages of the disease the gland is large and vascular; in the later, small and contracted. This form of pancreatitis is of surgical importance because of the obstruction it may cause in the bile and pancreatic ducts. It is frequently associated with diabetes. The etiology is obscure, though pancreatic calculi or antecedent (suppurative) processes in adjacent organs may be possible causes.

The *indications for operative treatment* are the symptoms of stricture of the common duct, with retention of bile or of pancreatic fluid. Persistent jaundice and emaciation, with little or no pain, suggest obstruction of pancreatic origin.

Surgical Treatment.—The only surgical treatment consists in cholecyst-enterostomy, an operation for the relief of the biliary obstruction.

Pancreatic Hemorrhage.—Extensive hemorrhages into the pancreas and peripancreatic tissues may be the cause of sudden death. This, however, must not be confounded with the hemorrhagic form of pancreatitis. Slight hemorrhages into the body of the gland may cause hemorrhagic cysts of the pancreas.

Pancreatic calculi are usually small, multiple, and white. In rare instances a single large stone is found. The calculi consist of phosphate or carbonate of lime. Pancreatic calculi have no surgical interest except that they may be the cause of pancreatic cysts and of chronic pancreatitis.

Cysts of the pancreas are usually retention-cysts due to the impaction of calculi in the pancreatic duct.

Cysts of the pancreas may result from—

(*a*) Obstruction of the pancreatic duct by calculi, with attendant changes in the parenchyma of the gland;

(*b*) Obstruction from cicatricial contractions of the duct;

(*c*) Obstruction of the duct from displacement of the pancreas;

(*d*) Obstruction of the duct from trauma.

Cysts of the pancreas are globular in shape and may be as large as a man's head. In cysts of rapid formation the wall is thin from distention; in those of slower growth it is thick; it may be cartilaginous or ossified. An accessory pancreas may be the starting-point of the cyst.

The SYMPTOMS of pancreatic cyst are chiefly local—indefinite pain or discomfort in the epigastrium, disturbances of intestinal digestion, varying in severity according to the amount of pancreatic fluid shut off from the duodenum. In some cases diabetes is present. The tumor itself is characteristic: it fills the space occupied by the pancreas and causes a symmetrical swelling in the epigastrium. It is often so tense as to seem solid.

The DIAGNOSIS must be made from the presence and physical attributes of the tumor. To determine the latter aspiration may be employed. Cysts of the pancreas must be distinguished from cysts of the peritoneum and mesentery and from malignant disease of the pancreas.

The operative treatment of pancreatic cysts should, in the vast majority of cases, be incision and drainage. A few cases have been reported in which complete extirpation of the cyst has been accomplished. The technical difficulties of extirpation practically exclude this operation, though enucleation of the cyst, if it can be effected without removing the entire gland, may be attempted. The dangers of enucleation are chiefly those of hemorrhage and shock. Drainage of pancreatic cysts should be made through a median incision between the umbilicus and the ensiform cartilage. Pancreatic fluid may be septic ; therefore great care must be taken not to infect the general peritoneal cavity. The incision into the cyst should be large enough to permit thorough exploration for stone. Drainage must be used until the discharge cease.

New growths of the pancreas may be sarcomata or carcinomata. *Sarcoma* is very rare. *Cancer of the pancreas* may be primary or secondary. It is usually of the scirrhous form, and situated in the head of the gland. New growths limited to the pancreas are seldom suspected, excepting when a *persistent cholæmia* suggests their presence.

SYMPTOMS OF CANCER OF THE PANCREAS.—Epigastric pain with progressive emaciation and cachexia, jaundice, diabetes, and fatty diarrhœa suggest malignant disease at the head of the pancreas. The symptoms, however, are variable. A deep-seated, movable tumor in the region of the pancreas may confirm the diagnosis.

Cancer of the pancreas must be differentiated from cancer of the *pylorus*, cancer of the *liver* and *gall-bladder*, cancer of the *intestines*, and *impacted gall-stones*. It is often impossible to make a differential diagnosis between a gall-stone impacted in the common duct and cancer of the head of the pancreas.

TREATMENT.—Radical excision of malignant disease of the pancreas offers great technical difficulties and slight chance of permanent cure. It should be attempted only in cases in which the disease is limited to the *tail* of the gland. Palliative treatment should be directed to the relief of the persistent jaundice. The operation demanded in these cases is chole-cyst-enterostomy. The anastomosis should be made, if possible, between the gall-bladder and the duodenum.

THE SPLEEN.

(For Wounds and Injuries of the Spleen see p. 341.)

Suppurative Splenitis ; Abscess and Gangrene of the Spleen.—The chief *causes* of suppuration of the spleen are septic embolism or infarcts, septic infection from without or within after injuries, and the extension of sepsis from neighboring organs. Diffuse abscesses of the spleen are uncommon. The process is usually circumscribed. In several pyæmic conditions hemorrhagic infarcts of the spleen are not uncommon. Single or multiple abscesses, small in size, may enlarge and coalesce into a single large abscess sac involving the whole organ. *Perisplenitis* may result with adhesions to surrounding parts, which may guide the pus into the abdominal or thoracic cavity, the stomach, or intestines. Primary

suppurative splenitis occurring in malarial or typhoidal conditions is caused by septic infection of an organ the vitality of which has been weakened by constitutional disease—an organ made still more susceptible by vascular engorgement.

The SYMPTOMS of splenic abscess are vague. Unless the capsule is involved, pain will not be present. Though *hectic fever* may result, it is of little value as a symptom, because splenitis is usually secondary to a general febrile disease. The vomiting of pus or blood or its passage in the stools may occur, though rarely.

The chief points of DIAGNOSIS are *enlargement and tenderness* of the spleen, and possibly the presence of fluctuation. The majority of cases result fatally, before the condition is suspected. When an abscess of the spleen can be made out, *incision and drainage* are indicated. Aspiration of the spleen is dangerous and should seldom be attempted.

Gangrene of the spleen is the result of intense septic infection of the spleen. Its course is so rapid and fatal that surgical treatment is rarely if ever indicated.

Displacement of the Spleen.—Stretching of the ligaments of the spleen allows change in the normal position of the organ. Extreme changes in position other than traumatic prolapse and dislocation are found whenever chronic enlargement of the spleen has caused abnormal stretching of the ligaments. In rare cases the elongation of the ligaments may be congenital, but usually the condition is gradually acquired. Ultimately the spleen may be found in the hypogastric or umbilical region, the iliac fossæ, or the pelvis. The chief cause of wandering spleen is hypertrophy.

The SYMPTOMS of wandering spleen are those of dragging of the enlarged organ upon the stomach and the pancreas, the circulation of which, as well as of the spleen itself, may be impaired. The splenic ligament in extreme cases becomes stretched into a long pedicle, the twisting of which has been known to cause gangrene of the spleen. *Pain* may be constant; it is produced by dragging on the stomach or pancreas or by dragging on adhesions to other organs.

The DIAGNOSIS is to be made from the characteristic shape of the splenic tumor, with the recognition of the hilum. The normal area of splenic dulness is replaced by an area of tympany. In most cases of wandering spleen the size of the tumor far exceeds the normal size of the gland.

The TREATMENT of this affection may be palliative or operative. A trial of palliative measures should be made when the mobility is slight and the symptoms are mild. With the patient in the dorsal decubitus the spleen should be held in normal position by means of compresses and ice-bags. If the hypertrophy of the displaced spleen be due to malaria, an attempt to reduce the size of the organ by medical treatment may be made. Except in one or two instances, splenectomy has been the only means of radical cure. The mortality of splenectomies for this cause has been slight. (For the operation of splenectomy see page 398.)

Hypertrophies and Tumors of the Spleen.—Hypertrophies of the spleen, aside from the acute enlargement occurring in the course of infectious diseases, are (1) simple or idiopathic; (2) malarial; (3) leukæmic and pseudo-leukæmic.

Idiopathic hypertrophy of the spleen is a chronic hyperplasia occurring without changes in the blood or the lymph-nodes. The etiology is obscure.

The DIAGNOSIS of idiopathic hypertrophy can only be made after eliminating other possible causes of hypertrophy. Chronic malaria is the commonest cause. Leukæmic and pseudo-leukæmic enlargements of the spleen are secondary to morbid changes in the blood- and lymph-systems. Leukæmic conditions absolutely contraindicate surgical interference. Chronic enlargement of the spleen occurs also in cirrhosis and other chronic diseases of the liver, in chronic pulmonary diseases which cause passive congestions, in syphilis and amyloid diseases. Surgically it is unimportant.

New Growths of the Spleen.—*Cancer* and *sarcoma* of the spleen are very rare, and are usually secondary growths, though cancer has been known to be primary in the spleen. *Cysts* of the spleen may be simple serous cysts, blood-cysts, or hydatid cysts. Cysts which contain blood or serous fluid are of anatomical rather than of surgical interest, and rarely justify operative interference.

The splenic cyst is usually due to the echinococcus. The development of the cyst is slow, and the symptoms are entirely those of pressure—pain in the back and left flank, the sensations of pressure on the stomach and intestines. The DIAGNOSIS is impossible except in the presence of a tumor. Differential diagnosis must be made between hydronephrosis, new growths, and cysts of the ovary and the pancreas. A hydatid bruit and fluctuation may be present. When exploration of a splenic tumor is demanded, laparotomy rather than aspiration is indicated, on account of the liability to hemorrhage and extravasation from the use of the needle.

OPERATIVE TREATMENT OF SPLENIC TUMORS.—Because of the uncertainty of diagnosis in cases of splenic tumor the surgeon can never know before exposing the spleen whether a *splenotomy* or a *splenectomy* must be performed. The choice depends upon the appearance of the organ after exposure and the results of aspiration. The operation of splenotomy should be reserved for cases of cyst and of abscess.

Laparo-splenotomy formerly meant extirpation of the spleen, but at present its use is restricted to cases in which a cyst or abscess of the spleen is drained through an incision. The incision should be made at the border of the ribs, over the most prominent portion of the tumor. The chief care in the operation is the prevention of a general septic peritoneal infection. Adequate drainage of the abscess-cavity should be provided by means of tubes and gauze.

Splenectomy has been performed for leukæmic hypertrophy, malarial hypertrophy, simple hypertrophy and wandering spleen, cysts of the spleen, malignant disease, abscess and inflammatory changes, syphilis and amyloid degeneration, wounds and ruptures.

Surgical interference in leukæmic enlargement of the spleen is contraindicated, with the possible exception of those cases in which the changes in the blood and in the lymph-system are slight and the splenic tumor large. Practically, splenectomy is justifiable in simple or malarial hypertrophy, in wandering spleen, in cyst, in abscess, wounds, and ruptures, and rarely in cases of malignant disease.

The incision for splenectomy should be made on the left side of the abdomen along the border of the ribs. The situation and extent of the incision should in all cases be such as to facilitate the securing of the

splenic artery, for the chief danger in the operation is hemorrhage. The incision should be made large enough to admit the hand, in order that thorough exploration of the tumor and its attachments may be made. The pedicle should be tied with large silk, and if bloodless may be dropped into the abdomen. Venous hemorrhage should be controlled by ligatures and gauze packing.

Splenopexis, for securing the wandering spleen in its normal position by means of sutures, has recently been advocated as a routine treatment by Rydygier. At present no opinion as to the value of the operation can be expressed.

SURGERY OF THE LIVER.

(For Wounds and Injuries of the Liver see p. 341.)

Displacements of the Liver.—Congenital displacements of the liver may be either transposition of the entire organ, as in *situs transversus,* or hernia of the liver into the abdominal cavity through some defect in the abdominal wall (see Fig. 186 in Chapter IX.), or into the thoracic cavity through a deficiency in the diaphragm.

The normal liver, within certain limits, is freely movable, rising or falling with intra-thoracic or intra-abdominal pressure. Stretching of the ligaments of the liver, especially the suspensory ligament, occasionally results in abnormal displacement of the liver or what is called *floating liver.* This lesion is four times as common in women as in men. The chief cause is repeated pregnancies, associated with pendulous abdomens. The only symptoms are those of pressure—dyspnœa, nausea, vomiting, cyanosis, and occasionally jaundice.

The DIAGNOSIS may be made from the characteristic shape of the tumor and the presence of tympany in the usual area of liver dulness; also from the ease with which the tumor may be replaced in the normal position of the liver.

The only TREATMENT should be the application of bandages to hold the organ in place.

Abscess of the liver is due to invasion by septic organisms. Traumatism—contused, lacerated, or penetrating wounds—is a predisposing cause. Abscesses of the liver may be of the *solitary* or *tropical* form, the *multiple embolic* or *pyæmic* form; they may result from *gall-stones* or from *suppuration in the bile-ducts.* Rarely *foreign bodies* may pass from the stomach or the intestine into the liver and cause suppuration. *Intestinal round-worms* are a possible cause of abscesses in the liver, especially in children.

The bacteria of suppuration gain access to the liver through the circulatory or biliary systems (colon bacillus). The main route of infection is by the portal vein, through which infective processes in the intestinal tract become a frequent cause of hepatic abscess.

The solitary or tropical abscess is most frequent in hot climates. It may be single or double, but is never multiple. The abscess-cavity may involve nearly the whole liver, but in about 70 per cent. of the cases it affects the right lobe only. The infection is generally of dysenteric origin, due to the invasion of the amœbæ coli from the intestinal tract. The suppurative process may be limited by encapsulation, in which case the pus is generally sterile.

Hepatic abscesses may rupture into the lungs, the pleuræ, the

pericardium, the peritoneum, the intestines, the bile-ducts, or the gall-bladder, or they may perforate externally.

Multiple abscesses of the liver are always secondary to a septic focus elsewhere. They may be caused by gastric or typhoid ulcers, by fissure or ulceration of the rectum, by appendicitis, and by injuries to or operations upon the head. This disease is always associated with severe pyæmic symptoms, the infectious process taking the form of a suppurative pylephlebitis. Section of the liver will show multiple collections of pus in direct communication with the branches of the portal vein.

Extension of suppurative processes from the gall-bladder or from the gall-ducts may lead to a general suppuration in the liver—a lesion not associated with so rapid or so severe a general sepsis as is the case in embolic abscesses. Hepatic abscess is sometimes, though very rarely, coincident with, if not dependent upon, cancer of the liver. Without exploration the complication can be only suspected.

DIAGNOSIS.—In contusions and penetrating wounds of the liver septic infection can be detected by the usual signs of localized peritonitis —pain, tenderness, and fever.

In some cases of solitary abscess the disease may be latent and the lesion unsuspected. The chief symptoms of single abscess of the liver are *hectic fever*, *rigors*, marked general *sepsis*, *and profuse sweating*. *An enlargement of the liver* usually appears on the upper surface and in the right lobe, associated with tenderness on palpation and pain in the right hypochondrium, radiating into the right back and shoulder. *Jaundice is rare.*

The SYMPTOMS of multiple embolic abscesses are those of pyæmia, associated with an enlarged and tender liver. The general course of pyæmic abscesses of the liver is severe and the prognosis grave.

Abscess of the liver must be differentiated from *intermittent malarial fever*, *hydatid cyst of the liver*, *abscess of the abdominal wall*, *cancer of the liver*, *gall-stones*, *dilated gall-bladder*, and *right-sided pleurisy*. Examination of the blood for the organism of malaria is an important means of differentiation.

The DIAGNOSIS is confirmed by the presence in the stools of the amœbæ coli of dysentery. Cholelithiasis, with dilatation of the gall-bladder, is accompanied by a history of gall-stones, by paroxysmal pain, and by jaundice. The constitutional symptoms are much less severe. Hydatids are rare; their growth is slow. In the majority of cases there is no fever; pain comes on late and is not severe. The general condition is but slightly changed. The fluid withdrawn by the aspirating needle is clear and may contain the hooklets of the parasite. Suppurating hydatid cyst is with great difficulty distinguished from abscess of the liver. Cancer of the liver is generally a secondary growth. Jaundice is usually present and hectic fever absent. The tumor is hard and nodular. When cancer is associated with abscess its presence may not be suspected. Right-sided pleurisy, with effusion, must be diagnosticated by physical signs. Abscess in the abdominal wall gives no history of intestinal disturbance and presents less evidence of general sepsis.

TREATMENT.—Cases of solitary abscess or of suppuration following traumatism are the only ones in which surgical interference should be considered. The severe pyæmic condition and the dissemination of the pus-foci in multiple embolic abscesses contraindicate operation. The cases are almost invariably fatal. If from the presence of an external tumor

and from constitutional signs abscess of the liver is evident, the surgical treatment should be free incision and drainage. Thorough digital exploration should be made in search of possible sacculations and secondary abscess-cavities. Hemorrhage should be checked by gauze packing. The after-treatment is that of any internal abscess-cavity. The results in operated cases have been excellent.

Hydatid Cysts of the Liver (Fig. 177).—Hydatid disease is rare in America. The liver is the organ most frequently affected. The parasites reach the liver *from the intestinal tract* by the way of the portal vein. The growth of hydatid cysts of the liver is very slow, from four to twenty-five years being the duration of their life. In many cases the cyst never attains sufficient size to cause symptoms; in many the disease is self-limited and the cyst becomes calcified.

From pressure in the region of the liver large cysts cause pain and a feeling of weight; from pressure on the diaphragm, dyspnœa and cough; from pressure on the portal vein or bile-duct, ascites, jaundice, and enlargement of the spleen. The cyst may rupture into the pleuræ or lungs, into the peritoneum, or externally. Spontaneous cure has resulted from perforation into the intestinal tract. The general condition is usually but little affected. When suppuration in the cyst-fluid occurs, the symptoms suddenly become those of hepatic abscess.

The DIAGNOSIS may be impossible unless the cyst is such as to be easily palpated through the abdominal wall. The cysts, especially when multi-locular, are sometimes of great size (Fig. 177); frequently their irregularity in shape may suggest the nature of the disease. A painless enlargement in the liver, a fluctuant and tense tumor, and an occasional hydatid fre-

FIG. 177.

Hydatid cysts of a monkey's liver (Warren Museum).

mitus are suggestive signs. The disease has been mistaken for cancer, for hydronephrosis, for dilatation of the gall-bladder, for right-sided pleural effusion, and for abdominal aneurism. The tumor of an enlarged gall-bladder is pear-shaped, and is usually accompanied by a history of gall-stones or of catarrhal or obstructive jaundice. In cysts of the kidney the colon lies in front of the tumor; in hydatid cysts of the liver it lies behind. A cyst of the liver moves with respiration. When the diaphragm is pushed up by the pressure from hydatid cyst of the liver, the heart will be found more displaced than in cases of pleural effusion. In some instances it may be necessary to resort to the aspirating needle to establish the diagnosis.

TREATMENT.—When hydatid cysts of the liver are large enough to be diagnosticated with a fair degree of certainty, operation should be

performed. Aspiration, except as a diagnostic measure in obscure cases, is not to be advised, not only because of the dangers attending it, but because it will not remove the mother cyst. Electrolysis and injections of iodine have been tried without permanent success. In draining a hydatid cyst the incision should be made over the most prominent part of the tumor, the peritoneum cautiously opened, and the tumor exposed. Adhesions of the cyst to the parietal peritoneum are rarely found. After thoroughly walling off the general peritoneal cavity with gauze the tension of the cyst may be cautiously relieved by removing some of the fluid with the aspirating needle. After the cyst-cavity has been thoroughly evacuated through free incision and digital exploration, its wall should be stitched to the parietal peritoneum and the sac packed with gauze around drainage-tubes. The *after-treatment* consists in thorough antiseptic irrigation.

Total excision of a large hydatid cyst has been reported, as well as excision of several small cysts. The difficulties and dangers from hemorrhage in such a procedure contraindicate its adoption as the routine method of treatment.

Tumors of the Liver.—The forms of new growth found in the liver are carcinomata, sarcomata, angeiomata, gummata, and lymphomata. They are rarely, if ever, amenable to surgical treatment. Malignant growths in the liver are usually secondary. A few instances have been reported in which extirpation of primary sarcomatous or carcinomatous nodules in the liver has been attempted. The disease, however, has always rapidly returned, either in the liver or elsewhere.

Simple serous and dermoid cysts are occasionally found in the liver. When of sufficient size to be noticed they should be treated in the same way as hydatid cysts of the liver.

Cholelithiasis and Surgery of the Gall-bladder.

Malformations of the Gall-bladder.—Congenital absence of the gall-bladder and variations in the size and situation of the intestinal opening of the gall-duct have occasionally been noted.

Gall-stones are a common affection of middle and advanced life. Three-fourths of all the cases are found in women. Gall-stones are usually formed in the gall-bladder, very rarely in the small branches of the hepatic duct in the liver itself. Their formation probably is associated with some slowing of the biliary flow and with catarrhal disease of the mucous membrane. So long as gall-stones remain in the gall-bladder they may cause no symptoms. The *pathological effects* of gall-stones are—*biliary colic*, due to the passage of stones through the ducts, *obstruction of the ducts, and septic invasion, leading to suppuration* in the gall-bladder and ducts, to ulceration, perforation, abscess of the liver, etc.

Symptoms.—*Paroxysmal attacks of pain*, with or without brief *jaundice*, followed by periods of complete remission, point to the passage of gall-stones through the cystic duct. Persistent pain, with more or less persistent jaundice, indicates the slow passage of a biliary calculus from the gall-bladder through the common duct to the duodenum.

The DIAGNOSIS of gall-stone colic is generally easy, but it must be expected that at times cancer in the vicinity of the gall-bladder will be found associated with calculi. A certain percentage of cases, mainly the cases of the passage of stones through the cystic duct, have no jaundice. In these cases the diagnosis is not so evident. Youth in a patient makes the existence of malignant disease improbable.

Complete obstruction of the cystic duct from impaction of a stone or from other causes may result in a dilatation of the gall-bladder, which may attain enormous proportions. The tumor may fill the entire right half of the abdomen and even extend into the pelvis. In long-continued obstruction the fluid contents of the gall-bladder may be clear or slightly tinged with bile. Septic infection may take place, and cause empyema of the gall-bladder. A dilatation of this sort must be differentiated from cystic tumors of the kidney, pancreas, ovary, or mesentery. Dilatation of the gall-bladder from the impaction of calculi in the cystic duct is unattended by jaundice.

Impaction in the common duct usually causes marked dilatation of the gall-bladder; it causes dilatation of the branches of the hepatic duct, and may result in pronounced and fatal jaundice. Infection of the mucous membrane of the gall-bladder or of the biliary ducts may occur at any time through minute injuries to the epithelium. The usual forms of bacteria are the bacillus coli communis, the streptococcus, and various staphylococci. Infection through the cystic duct may cause empyema of a dilated gall-bladder; it may convert a *catarrhal cholangitis*, the

FIG. 178.

Gall-bladder contracted upon a gall-stone (Warren Museum).

usual accompaniment of gall-stone impactions in the common duct, into a suppurative cholangitis, from which abscess of the liver may result. **Acute phlegmonous cystitis** may occur as an indirect sequence. The so-called hepatic fever commonly ascribed to chronic catarrhal cholangitis

of the common duct is probably due to septic causes. The septic process may cause ulceration and perforation of the gall-bladder or its ducts; it often extends to the peritoneal coats, causing firm adhesions of the gall-bladder to neighboring structures. It is not uncommon to find the gall-bladder thickened and contracted upon a large stone (Fig. 178), buried in firm adhesions extending to the colon, the duodenum, or the pylorus. Such adhesions greatly increase the difficulties of operations upon the gall-bladder.

Perforation of the gall-bladder or ducts from the ulceration of calculi or from rupture may result in external or internal fistulæ, or in direct extravasation into the general abdominal cavity, with general or local peritonitis (Fig. 179.) Perforation may take place into the

Fig. 179.

Perforating ulcer of the gall-bladder causing death from peritonitis (Warren Museum).

pleura or into the lung. Internal biliary fistulæ have been found between the gall-bladder and the intestines; rarely between the gall-bladder and the stomach, and still more rarely between the gall- and the urinary bladder; in the majority of cases perforation takes place into the duodenum. Large gall-stones not infrequently ulcerate into the intestinal tract and become a cause of acute obstruction.

Strictures in the common duct, and also in the cystic, usually originate from an old gall-stone impaction through the cicatricial contraction of the injured mucous membrane; they may be occasionally due to catarrhal or diphtheritic ulceration.

The DIAGNOSIS of biliary colic must be made from the paroxysmal

nature of the attacks, with or without jaundice. The discovery of a gall-stone in the fæces will positively establish the diagnosis. Persistent pain and jaundice, following a history of a number of paroxysmal attacks, point to a stone in the common duct. When the chief symptom is jaundice, the diagnosis between a stone impacted in the common duct and malignant disease may be impossible. Indeed, cancer often complicates retained or impacted gall-stones. **Exploration** often shows that the jaundice is caused by the pressure of a malignant growth upon the common duct. Malignant disease, situated in the head of the pancreas and obstructing the biliary flow, most closely simulates an impacted stone. Obstruction of the duct by the pressure of non-malignant growths cannot be absolutely diagnosticated. Symptoms of jaundice and emaciation may be the result of a complete obstruction of benign origin, of hopeless intra-hepatic disease, or of the pressure of an extra-hepatic malignant growth. The completeness of the biliary obstruction is important. In many forms of intra-hepatic disease attended by jaundice there is a slight amount of biliary secretion, which makes its way into the intestine and may be found on examination of the fæces. In mechanical obstruction, on the other hand, the biliary flow is totally shut off by occlusion of the bile- or common ducts and the fæces contain no bile. Moreover, in a mechanical obstruction there may be temporary relaxation of the pressure causing it, with sudden appearance of bile in large quantities in the intestinal tract.

Cystic tumors of the kidney, pancreas, stomach, ovary, omentum, or mesentery, and hydatid cysts of the liver may at times be confounded with dilated gall-bladder unaccompanied by jaundice. The shape, location, and mobility of the tumor, with the evidence gained by aspiration, throw light upon the diagnosis. In some cases the diagnosis can be made only by exploratory operation.

Indications for Operation.—Prolonged pain in the region of the gall-bladder, cholæmia without pain and without positive evidence of organic disease, and paroxysmal pain, with the discovery of gall-stones in the fæces, are conditions demanding operative interference. Distinct evidences of malignant disease, such as nodular masses in the liver, with cachexia, contraindicate operation, except for the relief of pain, and then only when gall-stones are diagnosticated. Marked diminution in the size of the liver, associated with ascites, contraindicates interference.

Surgical Treatment.—**Cholecystotomy.**—This operation consists in incision of the gall-bladder. The gall-bladder is first sewed into the abdominal wound ; it may be incised at once, or the opening may be deferred for two or three days. Ideal cholecystotomy for gall-stones consists in opening the gall-bladder immediately, removing the stone, closing the wound in the gall-bladder by interrupted Lembert stitches, replacing it in the abdominal cavity, and closing the abdominal wound. When practicable, this is a better method than that of leaving the gall-bladder open with permanent drainage, because a biliary fistula is thereby avoided. After drainage, the flow of bile may persist for many months and necessitate a second operation to close it. When the gall-bladder is so contracted that it cannot be sutured into the abdominal wound, *incision with drainage* or *total extirpation* may be performed. The method of drainage consists in the use of rubber drainage-tubes surrounded by gauze.

Cholecystectomy.—Extirpation of the gall-bladder is desirable when its walls are thickened and friable and contracted upon one or more stones. The stones may be removed and extravasation may be avoided by tying off and removing the gall-bladder, stones and all. This procedure should not be attempted unless the gall-bladder can be separated easily from adjoining structures. Drainage is a wise precaution after this operation.

In malignant disease of the gall-bladder total extirpation is the only operation offering any chance of permanent cure. The operation is justifiable only when the disease is limited to the gall-bladder.

Operations upon the Cystic, Hepatic, and Common Ducts.—Few conditions of the cystic duct admit of operative manipulation. Removal of calculi in this duct by incision, if possible, is preferable to prolonged manipulation with the hands or with forceps. Operations upon the hepatic and common ducts are indicated when stones are impacted in either, and cannot be removed by dilatation of the cystic duct or by reasonable efforts at crushing. Care must be taken when making the incision to avoid the hepatic artery and the portal vein. After being incised, the ducts should be carefully closed with sutures.

The possibility of performing this operation will depend upon the build of the patient, the thickness of the abdominal wall, the depth of the wound, the number and firmness of adhesions, the reflections of the normal peritoneum, and the condition of the duodenum, stomach, and colon. Even when the sutures have been accurately applied provision for leakage of bile must be made. In all operations on the gall-bladder or ducts great care must be taken to avoid contamination of the peritoneum with bile.

Cholecystenterostomy.—In chronic, organic, non-calculous obstruction between the liver and the duodenum, in order to avoid a chronic and fatal cholæmia provision must be made for the artificial escape of bile, either externally or into the intestine. *Anastomosis between the gall-bladder and the duodenum* is to be preferred, but when the local anatomical conditions render this impossible *deviation of the bile-flow into the colon may be effected.* Anastomosis may be made without the aid of mechanical devices or with the aid of Senn's plates or the Murphy button. Many cases of the successful performance of this operation with the Murphy button have been reported within the last two or three years.

If for any reason the gall-bladder cannot be utilized in making the anastomosis, in some cases the common duct may be isolated above the obstruction and fastened into the duodenum or the colon. Such a procedure may be possible when the obstruction is near the duodenum. Operations upon the common duct by way of the internal surface of the duodenum may be practised under exceptional circumstances. Organic obstructions situated in the hepatic duct, above the juncture with the cystic, admit of no relief, except occasionally by the formation of a biliary fistula above the constriction.

CHAPTER IX.

HERNIA.

By Maurice H. Richardson, M. D.

THE protrusion of an internal organ through a congenital or an acquired opening in confining structures is called hernia of that organ. The term **hernia** must be qualified to denote the organ involved, as *hernia cerebri, hernia testis*, etc. *Hernia* used alone means, as a surgical term, a protrusion of the intestine, of the omentum, or of both from the cavity of the abdomen through some defect in its parietes.

Herniæ are best classified according to their anatomical situation :

Inguinal, { Indirect, { Congenital, Funicular, Infantile, Acquired. } Direct, Acquired. }

Femoral.

Umbilical, { Congenital, Infantile, Acquired. }

Ventral hernia and herniæ in the linea alba (other than umbilical), { Epigastric. As the result of laparotomy or other wounds. As the result of congenital failure of development. }

Diaphragmatic, { Congenital, Acquired—Traumatic. }

Gluteal or *Ischiatic.*
Obturator.
Perineal.
Lumbar.
Sacro-rectal.
Retroperitoneal.
Properitoneal.

Herniæ are either congenital or acquired. Congenital herniæ are caused by developmental defects in the peritoneum or in the abdominal wall. The chief cause of acquired hernia is increased abdominal pressure, constant or intermittent. Acquired herniæ may be of slow or of sudden development. Increased abdominal pressure may be due to—

1. *Occupation* (involving sudden and severe exertion, especially in a stooping posture).
2. *Pregnancy* (pressure upon and weakening of the abdominal wall).

3. *Disease—*
  (*a*) Chronic lung affections (cough) ;
  (*b*) Stricture of the urethra (straining) ;
  (*c*) Prostatic hypertrophy or urinary calculus (straining) ;
  (*d*) Phimosis (straining) ;
  (*e*) Constipation (straining) ;
  (*f*) Ascites (pressure upon and weakening of the abdominal walls) ;
  (*g*) Abdominal tumors (pressure upon and weakening of the abdominal walls).

Other causes contribute more or less directly to the production of hernia. Among them are simple weakness of the abdominal walls, trauma, and surgical operations.

Trauma, except as a cause of strain, rarely causes hernia. It may, however, produce a ventral hernia by direct rupture of the abdominal muscles. Laparotomy wounds are prolific sources of ventral hernia, especially those which cannot be immediately closed because of the necessity for drainage. Even in abdominal incisions which are immediately sutured, and which heal by first intention, a very considerable number of herniæ result.

Anatomically a hernia consists of the *sac* (peritoneum), the *contents* of the sac (bowel, omentum, or both), and its *external coverings* (muscles, fasciæ, and skin).

The sac is formed of peritoneum which is pushed ahead by the abdominal pressure exerted upon the protruding viscus, usually intestine and omentum. There is at first a bulging of the peritoneum, then a conical protrusion, which more and more effectively dilates the weakening parietes. As soon as the dilatation is sufficiently large, a coil protrudes and pushes its way, with greater rapidity than before, among the less resistant structures of the abdominal wall. The escape through the muscular and aponeurotic layers is doubtless gradual and imperceptible; among the outer layers, rapid and conspicuous. Hernial tumors that suddenly appear after violent exertion have doubtless already made their way through the inguinal canal to the external ring; as, for example, inguinal hernia.

The *physical appearance* of the sac depends upon the age of the hernia, the degree of distention, the amount of irritation, etc. It may be opaque and thickened or translucent and thin, smooth, here and there constricted, easily separated from surrounding structures or intimately adherent to them.

In *congenital herniæ* the peritoneal pouch exists at birth; in *acquired*, it is formed by pressure through natural or accidental openings in the abdominal parietes. When the contents of the sac consist solely of intestine, the hernia is called an *enterocele ;* when they are made up of omentum, an *epiplocele ;* when of both intestines and omentum, an *entero-epiplocele.*

The structures that cover the hernial sac vary with the locality of the hernia. They consist of fasciæ, tendons, muscles, and skin. Anatomically these layers are distinct and traceable to definite structures derived from the abdominal wall; surgically they are indefinite, and, except the most characteristic, seldom distinguished.

The escape of abdominal viscera may cause at times not even annoyance; it may be attended by discomfort, and at times by severe pain. A simple reducible hernia may escape the patient's attention until a tumor is discovered or the pain of strangulation begins. (See Strangulated Hernia.)

The *physical evidence* of hernia consists in a tumor, more or less marked, at one of the usual seats of hernia. In size hernial tumors vary within extreme limits (Fig. 180). In the inguinal variety a scrotal tumor may reach to the knees without serious symptoms; a fatal strangulation may occur without a perceptible tumor. Umbilical and ventral herniæ sometimes attain enormous dimensions, and contain so large a proportion of the abdominal contents that the abdominal cavity in the course of years becomes too small to contain them on attempted reduction.

The Diagnosis of Hernia.—Hernia in general is recognized by the presence, at one of the usual seats of the lesion, of a painless tumor, which disappears in the recumbent posture and reappears in the erect; which even in the erect position can be replaced; which may be tympanitic, and which disappears with a gurgle. (For the diagnosis of special herniæ see Special Herniæ.)

The *physical examination* of a hernia should be made with the patient in the erect and then in the recumbent posture. The tumor should be palpated, percussed, and auscultated. (See Special Herniæ.)

The *contents* of a hernial sac may be easily returned to the abdominal cavity or they may be permanently fastened in the sac; they may become distended with impacted fecal masses; they may, with the sac, become inflamed; or they may become necrotic from the cutting off of the blood-supply.

Hernia clinically considered with reference to these conditions may be—

1. *Reducible.*
2. *Irreducible.*
3. *Incarcerated or obstructed.*
4. *Inflamed.*
5. *Strangulated and gangrenous.*

(*a*) A *reducible hernia* is one in which the contents of the sac can be readily returned to the abdominal cavity. Such a hernia appears as a rounded or pear-shaped tumor, usually soft and inelastic on palpation, tympanitic on percussion. It receives a perceptible impulse when the patient coughs; it is reduced with a distinct slip and gurgle. A reducible omental hernia suggests a superficial lipoma; it is dull on percussion, somewhat lobulated, and resistant on palpation. It gives a moderately marked impulse when the patient coughs; it is reduced slowly and without gurgle. The recognition of a reducible hernia made up of both omentum and intestine is often difficult.

(*b*) A *hernia is irreducible* when the contents of the sac cannot be returned into the abdominal cavity. Herniæ may become irreducible, first, from their large size; secondly, from adhesions between the sac and a portion of its contents; thirdly, from an excessive development of fat in the prolapsed omentum.

(*c*) A *hernia is obstructed or incarcerated* when the bowel in the sac of an irreducible hernia becomes obstructed by impacted fæces. It is usually seen in the aged, and is most common in the umbilical variety. An incarcerated hernia is dull on percussion, gives impulse on coughing, and is associated with obstipation, nausea, and vomiting; it is with-

out the severe symptoms of intestinal obstruction and bowel-necrosis seen in strangulation.

(*d*) *An inflamed hernia* is the result of violence, most often from the pressure of a badly-fitting truss. The parts are tender, red, and swollen ; the hernia is irreducible. Nausea, vomiting, and pyrexia are present to a slight degree ; but here, as in incarcerated hernia, the severe constitutional symptoms of acute obstruction and bowel-necrosis are absent.

(*e*) *Strangulated and Gangrenous Hernia.*—The strangulation of protruded gut or omentum begins whenever from unusual crowding into the hernial sac or from other causes the return of venous blood is impeded. Passive congestion then makes the bowel or omentum œdematous, increases the pressure within the sac, and augments each moment the disastrous action of the constricting ring. Venous stasis becomes complete. The arterial supply is next impeded, and finally cut off entirely. This interference with circulation causes *necrosis* of the constricted portion, which becomes gangrenous through the invasion of intestinal bacteria. Necrotic changes begin in the mucous membrane at the point of constriction. If the strangulation is unrelieved, the gangrenous process extends to the serous covering of the intestine, and eventually results in perforation. In the first hours the hernial sac becomes distended by exudation, the intestinal coils shrunken and dark colored. The exudate into the sac, sterile only in the early hours of strangulation, soon becomes *contaminated by the passage of bacteria through the altered bowel-wall.* Above the ring the distal loop of intestine is usually empty and contracted ; the proximal, distended with liquid fæces, becomes congested and œdematous, paretic and dilated. The constitutional symptoms of toxic absorption, aggravated by those of acute obstruction, as a rule, appear early—incessant vomiting, cold extremities, feeble and accelerated pulse, normal or subnormal temperature, cyanosis, and exhaustion. At times the depth of the systemic depression is out of all proportion to the severity of the local lesion. Death sometimes takes place before the pathological changes in the strangulated gut have advanced sufficiently to cause necrosis and perforation of the prolapsed coil. The fatal result often seen in the early hours of a strangulated hernia is probably due partly to shock from acute obstruction and incipient necrosis, and partly to toxæmic absorption from pathogenic bacteria.

SYMPTOMS.—The symptoms of strangulated hernia are general, calling attention to the abdomen, and local, calling attention to a hernial tumor. The *general symptoms* are those of acute intestinal obstruction. They may come on suddenly, without premonition, or in gradually increasing peristaltic paroxysms. The general symptoms of simple mechanical obstruction become aggravated by those of septic absorption as soon as necrosis within the sac takes place.

General peritoneal infections occur but rarely in strangulated hernia, being prevented by adhesions at the constricting ring. The effect of strangulation-necroses upon the patient varies with his susceptibility to infection and his powers of endurance. (See Acute Intestinal Obstruction.) Some patients succumb in a few hours ; others survive the constitutional and local strain of spontaneous cure through a fecal abscess and artificial anus.

The *local signs* of a strangulated hernia are at first confined to changes in the hernial tumor. The later local symptoms become merged in those of acute obstruction, with or without general peritonitis.

The *general symptoms of acute obstruction dependent upon a strangulated hernia* are accompanied usually, though not invariably, by a tumor at one of the ordinary seats of hernia. The exception is seen when a coil, slightly protruding through a ring, is strangulated deep below a thick layer of fat. The *tumor of strangulated hernia is tense, elastic, and incompressible.* It is tender on palpation and dull on percussion. The dulness (fluid from passive congestion) may give place to tympanitic resonance if the effused fluid is slight and the intestine distended with gas. As a rule, however, most tumors of strangulated hernia

Fig. 180.

Scrotal hernia (Massachusetts General Hospital, Dr. H. H. G. Beach).

are dull, not only from fluid transuded into the sac, but from fluid poured into the intestine itself.

The color of a strangulated hernia varies from dark red to greenish gray. The different shades of red indicate generally a viable gut ;

green, a more or less complete gangrene. A dark wine color is the shade most commonly seen. Such a color means a viable intestine, and it is replaced by the bright red of an acute congestion as soon as the strangulation is reduced. (See Treatment of Strangulated Hernia.) Plate X.

A coil is hopelessly damaged if in addition to its shade of green it has a fecal odor or if there is a distinct fecal escape. At times the necrosis is limited to a small patch here and there; at other times the whole affected coil is melted into an offensive sloughing mass.

Inguinal hernia (Figs. 181, 182) comprises 80 per cent. of all cases. It occurs usually in males, and most frequently in the early years of life. In inguinal hernia the intestine makes its way out of the external abdominal ring (Fig. 182), either by way of the internal ring and the inguinal canal or directly through the abdominal wall beneath the external ring. The former is called *indirect inguinal hernia,* the latter

FIG. 181.
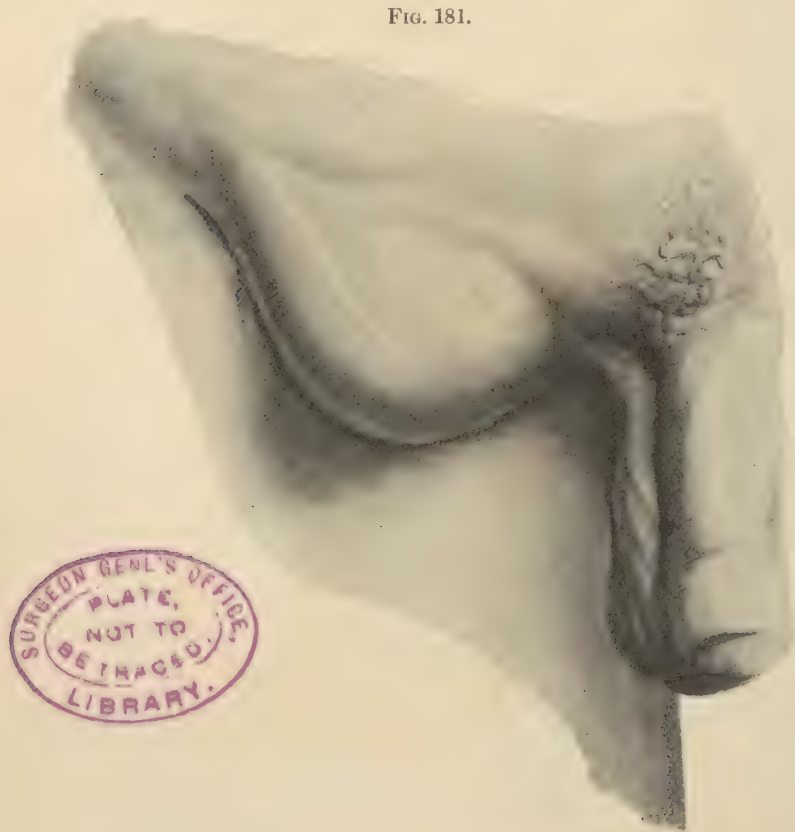
Indirect inguinal hernia (bubonocele) (original).

direct. Indirect inguinal hernia is either congenital or acquired; direct inguinal hernia is always acquired.

In the indirect form of inguinal hernia the protruding viscus may be

PLATE X.

Strangulated Inguinal Hernia; Intestine Discolored but still Viable. (Richardson.)

confined in the inguinal canal above the external ring. Such a form is *incomplete,* and from its suggestive appearance is called a **bubonocele** (Fig. 181).

Indirect inguinal hernia, appearing in the first few months of life, is of three varieties—*congenital, funicular,* and *infantile or encysted.* The occurrence of these three forms depends upon the extent and manner of closure of the vaginal process of the peritoneum, which in the later months of fœtal life is carried with the descent of the testis through the inguinal canal into the scrotum. At birth this process is normally obliterated and replaced by a small fibrous cord.

1. *Congenital Inguinal Hernia.*—In this form of inguinal hernia the vaginal process of the peritoneum remains open throughout its entire length (Fig. 183).

FIG. 182.

Scrotal hernia, showing the upper surface of the ring, with omentum entering it; the inner surface of the sac is exposed with its contents—omentum, and the relations of the latter to the testicle. The ring is closed by the prolapsed omentum, which is adherent so that no intestine can enter the sac (Warren Museum).

2. *Funicular hernia,* or hernia into the funicular process. The vaginal process of the peritoneum in this variety of hernia is closed just above the epididymis, as shown in Fig. 184.

3. *Infantile Encysted Hernia.*—The vaginal process has been closed at the internal inguinal ring ; the protruding intestine presses this septum

into the lower portion, forming a sac of three layers of peritoneum, as will be seen in Fig. 185.

The congenital forms of hernia may be present at birth; they may appear soon after birth, or, in rare instances, in adult life. Congenital hernia is not infrequently associated with a retained testis. In young

FIG. 183.   FIG. 184.   FIG. 185.
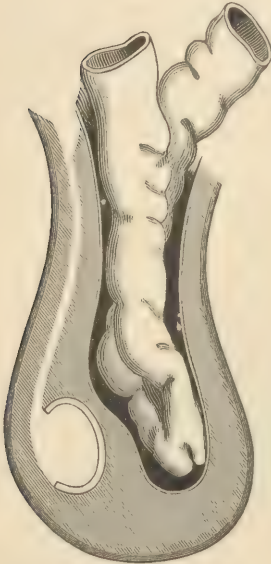
Congenital inguinal hernia.   Infantile or encysted hernia.   Hernia of the funicular process.

girls indirect inguinal hernia along the canal of Nuck is the commonest form.

4. *Acquired Indirect Hernia.*—In this form of inguinal hernia the sac has been pushed along the inguinal canal in front of the viscera. It rarely appears before adult life, for its development is generally slow.

Indirect inguinal hernia may show itself, first, as a tumor above Poupart's ligament outside of the external ring (bubonocele, Fig. 181). In most cases, however, it first appears at the external ring as a small, soft, painless, easily-reducible tumor, hardly perceptible except by digital examination through the invaginated scrotum. In neglected cases the tumor increases in size by pushing aside the elastic structures about it, until it fills and distends the scrotum (scrotal hernia, Figs. 180, 182).

The coverings of indirect hernia are derived from the muscles and aponeuroses of the abdominal wall, each structure giving a layer with a special name. For all practical purposes that taken from the peritoneum, the sac, is the only one of importance.

Between the sac and the skin lie the strata corresponding to the skin, the superficial fascia (dartos), the external oblique (intercolumnar), the internal oblique (cremasteric), the transversalis fascia (infundibuliform). With the exception of the cremasteric, which may be recognized by bundles of longitudinal and looped muscular fibres, none of these intermediate layers can be easily recognized.

Their practical importance is so slight that they hardly deserve the space taken to name them.

Direct inguinal hernia occurs in adult life, is usually of acute origin, and frequently becomes strangulated. The hernia takes place directly through the abdominal wall at the triangular depression formed by the deep epigastric artery on the outer side, the obliterated hypogastric artery on the inner side, and Poupart's ligament below—the triangle of Hesselbach—and appears at the external abdominal ring.

Diagnosis of Inguinal Hernia.—The close proximity of the anatomical seat of femoral hernia to that of inguinal necessitates careful recognition of important anatomical landmarks in making a differential diagnosis. The relation of the neck of the hernial sac to Poupart's ligament, to the spine of the pubes, and to the deep epigastric artery must be determined in every case. *Inguinal herniæ* emerge above Poupart's ligament, *femoral herniæ* below it.

Indirect inguinal herniæ, unless very large, present an oblong prominence just above and parallel to Poupart's ligament, starting at the internal ring. Direct inguinal herniæ are usually small and nearer the median line. The deep epigastric artery lies to the inner side of the indirect variety, to the outer side of the direct. When the hernia is old and the ring large it is impossible to distinguish between the direct and the indirect varieties by the relative position of the rings or by the direction of the neck, because long-continued pressure approximates the two rings, bringing the one almost directly behind the other. If the epigastric artery can be felt, either before or during operation, its relation to the neck of the sac will demonstrate the variety of hernia present. Femoral herniæ emerge beneath Poupart's ligament, and are reflected upward upon the abdominal wall by the pubic portion of the fascia lata.

Herniæ in the inguinal region must be distinguished also from other forms of tumor—*varicocele*, the different forms of *hydrocele*, enlarged inguinal or femoral *nodes, aneurism, psoas abscess, undescended testis*, and *malignant disease.*

A *varicocele* gives no distinct impulse on coughing, it disappears in the recumbent position and reappears in the erect, even when firm pressure is made over the inguinal ring; palpated, it suggests a bunch of earth-worms. A *congenital hydrocele* is translucent, gives no impulse on coughing, disappears with the recumbent position, reappears slowly in the erect, and is dull on percussion. The *coexistence of hydrocele and hernia* renders diagnosis difficult. An encysted hydrocele of the cord is persistent, fluctuating, does not disappear in the recumbent position, and gives no impulse on coughing. An *hæmatocele* is caused by traumatism; is dull, opaque, and gives no impulse on coughing.

Femoral Hernia.—This variety of hernia is next in frequency to the inguinal, occurring in 10 per cent. of all cases. It is found most commonly in women. *Femoral hernia is always acquired and is very liable to strangulation.* The protrusion takes place through the femoral ring into the femoral canal, a passage about half an inch in length between the iliac, crural, and pectineal portions of the fascia lata. The hernia usually lies to the inner side of the femoral vein.

Femoral herniæ emerge through the saphenous opening of the fascia lata, and are directed upward and outward upon the abdomen. The point of constriction in this variety of hernia is at Gimbernat's ligament.

For the diagnosis of femoral hernia, see Differential Diagnosis under Inguinal Hernia; for the treatment of femoral hernia, see Treatment of Hernia.

Umbilical Hernia.—1, *Congenital;* 2, *Infantile;* 3, *Acquired.*

1. *Congenital umbilical hernia* is due to defective closure of the

omphalo-mesenteric duct. The sac is translucent; through it the hernial contents can often be seen. The hernia consists usually of some portion of the intestine, but may be made up of the whole or of part of any of the abdominal viscera. (See Fig. 186, case of congenital umbilical hernia of liver.)

Fig. 186.

Hernia of liver through congenital opening in the umbilicus (Dr. J. C. Warren, Massachusetts General Hospital).

The TREATMENT of this form of umbilical hernia may be palliative or operative. Palliative treatment consists in the application of suitable pads; operative, in removal of the sac, reduction of its contents, and closure of the ring. It is generally necessary to operate within a few hours after birth.

2. *Infantile umbilical hernia* is the commonest variety of umbilical hernia. It generally appears between the second and sixth months of infancy. It is due to the stretching of the fibrous tissues of the umbilicus in the straining caused by coughing, crying, constipation, phimosis, etc. The tumor is rarely larger than the tip of the finger. Its contents are almost invariably small intestine. The prognosis in this variety is good; strangulation never occurs. In the majority of cases spontaneous cure results. The treatment consists in the use of small, hard pads, carefully adjusted, and in the removal of the usual causes of strain. Operation is seldom required.

3. *Acquired umbilical hernia* occurs most frequently in women advanced in years. Pregnancy, ascites, abdominal tumors, excessive development of adipose tissue—in fact, all conditions of excessive and long-continued distention—are exciting causes. The hernial sac often contains only omentum, although it may contain both omentum and intestine. *Strangulation* of the intestinal portion of an umbilical hernia is common. An omental umbilical hernia generally becomes incarcerated, and constantly tends to increase in volume from hypertrophy of fat-tissue. This form of hernia is associated with severe gastro-intestinal symptoms—indigestion, nausea, pain, constipation, etc., caused by traction of the omentum upon the colon and the stomach. (For treatment of umbilical hernia see Treatment of Hernia.)

Ventral Hernia.—*Epigastric hernia,* a lesion of rare occurrence,

consists in a protrusion usually of omentum in the linea alba between the ensiform cartilage and the umbilicus. It has the same predisposing causes as other hernia. It occurs, usually, in stout women. Epigastric hernia is generally slow in its development, and in its early stages presents a tumor too small to be easily perceptible. When large enough to be readily felt, it presents the characteristics of an omental umbilical hernia. The omentum, fixed in its abnormal position, drags upon the colon and stomach, causing discomfort and pain. Gastric and intestinal disorders and nervous phenomena often ensue. In the absence of an external tumor this form of hernia can be only suspected.

Hernia following Laparotomy and other Wounds.— *Ventral hernia* may take place through any portion of the abdominal parietes, though its usual situation is in the linea alba. Herniæ through the scar of laparotomy and other abdominal wounds are the commonest forms. Predisposing causes of this form of hernia are—

1. Sepsis in sutured abdominal wounds;
2. Stretching of cicatrices of open abdominal wounds;
3. Insufficient time in the recumbent position;
4. Any condition involving undue and persistent strain, especially upon broad granulation-cicatrices.

Strangulation in this form of hernia is a rare occurrence.

Hernia as the Result of Congenital Failure of Development.— Ventral hernia as the result of congenital defects in the abdominal wall may appear in any portion of the parietes, but is especially liable to occur in the line of muscular aponeuroses.

Diaphragmatic Hernia:

1. Congenital, through a defect in the diaphragm;
2. Acquired, through one of the natural openings in the diaphragm or through wounds or rupture of the diaphragm.

The hernial protrusion may vary in size from a small portion of intestine to one-half the contents of the abdomen. It is six times more common on the left side than on the right. In the acquired form symptoms of intestinal obstruction, after a wound of the diaphragm, indicate diaphragmatic hernia. In the congenital variety the heart is displaced to the right, and the lower part of the thorax is usually dull on percussion. *The condition is frequently confused with pyo-pneumothorax.* Traumatic cases have recovered after operation.

Gluteal or Ischiatic Hernia.—This form of hernia is very unusual. The hernia may take place through either the greater or the lesser sacro-sciatic foramen (Fig. 187).

Obturator hernia, usually occurring in stout women advanced in years, consists of a hernial protrusion along the vessels through the obturator foramen. The contents of the hernial sac may be either intestine or omentum. The diagnosis is impossible without the presence of an external tumor.

Perineal Hernia.—This rare and obscure form of hernia originates in Douglas's fossa, behind the bladder or uterus, on either side of the median line. The protruding viscus forces its way between the fibres of the levator ani muscle, and appears externally somewhere between the labium and the anus.

Lumbar Hernia.—This variety is very unusual, and consists in a

protrusion of abdominal contents, generally intestine, through the lumbar fascia, along the outer border of the quadratus lumborum muscle into the triangle of Petit. It is usually of small dimensions and can be

Fig. 187.

Ischiatic hernia (original).

easily reduced. It has been operated upon by mistake for fatty tumor and for cold abscess.

Sacro-rectal hernia is of great rarity, and is due to failure in ossification of the sacral bones.

Retroperitoneal Hernia.—This is a form of hernia into an internal peritoneal pouch. It usually occurs in the duodeno-jejunalis fossa. It may also take place in the region of the caecum or the sigmoid flexure. (See Internal Strangulations.)

Hernia through the foramen of Winslow may occur, though very rarely.

The SYMPTOMS, DIAGNOSIS, and TREATMENT of strangulated retroperitoneal herniæ do not differ from those of acute intestinal obstruction. When neither incarceration nor strangulation occurs the condition may never be even suspected.

Properitoneal Hernia.—This unusual variety of hernia may be a

complication of inguinal, femoral, or umbilical hernia. There must be two sacs with a common opening into the peritoneal cavity, the inner sac lying in the connective-tissue space in front of the peritoneum and behind the muscular layers of the abdominal wall, the outer sac occupying the position of an inguinal, femoral, or umbilical hernia. The usual cause of this condition is a mechanical separation of the peritoneum during attempts to reduce by taxis an existing hernia. A possible cause may be some congenital irregularity in the descent of the testis. Properitoneal hernia should be suspected when, after apparent reduction of inguinal, femoral, or umbilical hernia, there is no relief of symptoms (Fig. 188).

FIG. 188.
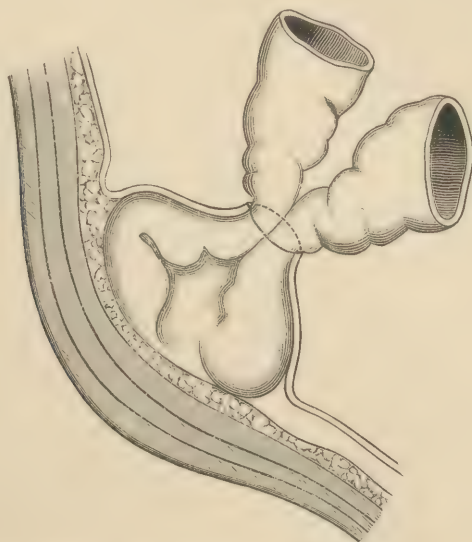
Properitoneal hernia. This illustrates also incomplete reduction of hernia.

Hernial Diverticula from the Bladder.—Portions of the urinary bladder have been found in inguinal and femoral herniæ. It is a rarity, and occurs usually in old persons. Urinary symptoms are vague and inconstant, and the condition is seldom diagnosticated before operation. The extraperitoneal portion of the bladder is prolapsed in the great majority of cases. This variety of hernia is sometimes called a cystocele.

TREATMENT.—If, as is rarely the case, the bladder is recognized before it has been injured, it should be freed and reduced. If the bladder has been opened, it should be closed by sutures and replaced. In certain cases, owing to necrotic changes, a temporary urinary fistula is inevitable; the wound must be left open and drained with gauze. A distinct adherent diverticulum may be dissected out.

Hernia of the Vermiform Appendix.—The vermiform appendix not infrequently appears in the sac of an inguinal hernia, either alone or with other parts of the intestine. Under ordinary circumstances its presence cannot be diagnosticated. If incarcerated, an acute appendicitis may develop, resulting in necrosis, gangrene, and abscess.

Treatment of Hernia.

Palliative Treatment of Hernia.—The palliative treatment of hernia consists in returning the protruded contents of the sac to the abdominal cavity and keeping them there. To restrain the abdominal contents, trusses and supporters are employed. Supporters are useful in large scrotal and umbilical herniæ which have become irreducible or which cannot be retained in the abdominal cavity.

Trusses are indicated in those cases in which restraint is practicable and complete. In all forms of hernia, and especially in those of early life, the use of trusses offers a reasonable expectation of cure. Trusses should, therefore, be faithfully used. The success of palliative treatment depends upon the closure and obliteration of the channel of escape. It is essential for the accomplishment of this end that the contents of the hernial sac be kept in the abdomen and never be allowed to escape for a moment may, by permitting a sudden recurrence, undo the work of months. The pressure of a truss doubtless aids greatly in the obliteration of the canal, if, indeed, it is not the chief factor. Trusses are necessary also in cases of reducible hernia, in which for some reason radical cure is contraindicated or refused. The proper truss should possess a steel spring of sufficient strength to retain the hernia; it should be elastic enough to follow the movements of the body and still remain in position; it should fit closely to the body just below the iliac crest, leaving the abdomen and gluteal muscles free; it should possess a pad of suitable material and shape to be retained over the hernial ring at all times. Pads may be made of wood, rubber, or ivory, and may or may not be covered with leather. Persistent pain and annoyance after the first few days of use show that the truss is unsuitable.

The employment of a truss, once begun, must be kept up continuously for a long period of time. Contraindications to the use of trusses are—

1. Irreducible omentum;
2. Irreducible, inflamed, and strangulated intestine;
3. A hydrocele on the same side;
4. Abnormal position of the testicle;
5. The lack of requisite time and care, due to incompetency, ignorance, poverty, or occupation;
6. Properitoneal hernia.

Non-operative measures for the treatment of irreducible hernia are *posture,* long-continued *moderate pressure,* and *taxis,* used separately or in combination, aided at times by the application of local heat or cold. By keeping the patient with the hips elevated, by applying the constant pressure of sand-bags over the hernial tumor, with gentle and persistent taxis, hernia of great dimensions can sometimes be successfully reduced. The patient may be kept for days with the foot of the bed raised and with sand-bags, gradually increased in weight, applied directly to the tumor. The treatment should be abandoned the moment it becomes painful.

In *obstructed hernia* the chief efforts should be directed to the relief of constipation—by means of high enemata and mild laxatives, with gentle massage of the tumor. Persistent obstruction demands exploration and mechanical relief.

Inflamed hernia should be treated by rest in bed and local applications of heat or cold. Efforts at reduction should be postponed until the subsidence of the local inflammation.

Irreducible, obstructed, and *inflamed hernia* should be closely watched for symptoms of *strangulation.* In doubtful cases the sac should be opened and a radical cure attempted. Considering the success which modern methods ensure, both as to immediate safety and permanent cure, palliative treatment, in the absence of

distinct contraindications, is justly deemed a greater risk, on the whole, than operation.

Operative Treatment of Hernia.—Irreducible herniæ, whether or not incarcerated or inflamed, should invariably be treated by open incision and radical cure. When for any reason operation is contraindicated or refused, reduction of the hernia by palliative methods should be attempted.

Treatment of Strangulated Hernia.—The great mortality in strangulated hernia being due to delay (acute intestinal obstruction, shock, gangrene of bowel, general peritonitis) or to violent taxis (rupture of bowel, extravasation, general peritonitis), it is imperative, first, that the treatment, whether by taxis or by operation, be entered upon at the earliest possible moment ; and secondly, that taxis should be employed for a brief period only.

TREATMENT by the use of ice-bags, by posture, or by palliative measures other than taxis promises so little, and, when *minutes* are precious, adds so materially to the delay, that these methods are mentioned only to be *condemned*.

Treatment by taxis is to be recommended in the very beginning of strangulation, for it often succeeds at that time. Moreover, the chief danger, rupture of the intestine, is unlikely to occur, even if the manipulations are forcible. In the later hours of a strangulation, when the bowel, swollen by congestion and œdema, is jammed through a tight ring into the sac, taxis is hopeless and worse than useless.

When employed, taxis must be gentle : its good effects, if any, will be the result of persistent and moderate, rather than of brief and forcible, manipulations. By compressing the sac between the thumb and fingers of both hands toward the ring, at the same time manipulating the tumor in various ways, the tension of the sac may, by the reduction of the gaseous or fluid contents of the constricted intestine, be relieved. Such a reduction—small though it may be—promises complete relief. In the case of femoral or of inguinal hernia reduction by taxis is encouraged by flexion of the thighs.

The *dangers of taxis* are as follows :

    1. Rupture or bruising of the intestine or sac ;
    2. Tearing of adhesions ;
    3. Reduction *en bloc ;*
    4. Fatal delay.

If persistent gentle pressure be unavailing, *herniotomy* is demanded.

In strangulated hernia the emergency to be met by operation is *acute intestinal obstruction.* This emergency may require merely *simple division of the constricting ring ;* it may require *intestinal resection* or *artificial anus.* Measures for radical cure may be considered in non-septic cases after the satisfactory relief of the obstruction.

The first step in herniotomy is exposure of the sac. In the usual forms of hernia—inguinal and femoral—the dissection should be made by layers until the sac is reached. The only layers recognizable, however, are the skin, fat, and possibly the dartos. *The sac is recognized usually by its color.* To make sure, the sac, with a bit of intestine, may be pinched between the thumb and the fore finger, when the intestine will slip away with a characteristic sensation, leaving the sac alone between the fingers. A little practice will make the sensation so familiar that it cannot be mistaken. The sac is now opened without fear of cutting the enclosed bowel.

In cutting down upon the sac in *umbilical hernia* the greatest care is necessary *not to wound the intestine,* for at times the gut is directly under the skin, and sepa-

rated from it by the peritoneum only. In some instances the skin over the strangu-
lated bowel is so thin that it takes the characteristic color of strangulated intestine.
The sac is usually distended with fluid which is clear, bloody, purulent, or fecal
according to the pathological condition of the affected gut. A cover-slip prepara-
tion made at the time may determine the question of sepsis, as well as that of the
advisability of drainage, radical cure, artificial anus, or resection.

The constricted bowel will be slightly congested, darkly congested,
here and there necrotic, or totally gangrenous. In the absence of
immediate bacteriological examination it may be difficult in doubtful
cases to determine the viability of the intestine. As a rule, a congested
gut, even if dark red, is viable ; a greenish one, necrotic. Macroscopic
perforation, total necrosis, or fecal abscesses are conspicuous. *The chief
point in doubtful cases is the determination of bowel integrity.* Inasmuch
as an absolute demonstration is impossible in such cases, safety and con-
servatism require that doubtful cases should be treated as if they were
septic.

The next step is division of the constricting ring.

In femoral and in inguinal hernia the division of the ring should be made with
reference to the position of arteries and veins : in inguinal, to that of the deep
epigastric artery ; in femoral, to that of the femoral vein. The operations of the
past were described in great detail in reference to these points, because of the desire
to make as small a cut as possible, and that blindly upon the finger. Though it is
still desirable not to enlarge the rings by free dissection, the parts may be clearly
demonstrated in doubtful cases, especially in inguinal hernia, in which by the best
of modern radical operations extensive dissections are essential.

Simple division may be made, however, upon the finger with a probe-
pointed bistoury ; in direct inguinal hernia the cut should be made
upward and inward, to avoid the deep epigastric artery ; in indirect,
upward and outward ; in femoral hernia, upward and inward, to avoid
the femoral vein. In the last form of hernia, however, an abnormal
obturator (derived from the epigastric) artery may be found impossible
of avoidance.

After division of the rings the bowel should be drawn out of the
wound until sound portions are visible, care being taken in septic cases
to protect the peritoneal cavity from infection.

The question of sepsis having now been determined by renewed
examinations, especially for signs of returning circulation, minute per-
forations, etc., there remains for the completion of the operation either
(1) *replacement* of sac-contents in the abdomen, (2) *intestinal resection,*
or (3) the formation of an *artificial anus.* After return of the gut in
aseptic cases the operation for radical cure should be performed. (See
Radical Cure of Hernia.)

The method selected will vary with the size of the rings, the extent of
the incision, etc. Resection of the intestine when its integrity is com-
promised should be performed only when the patient's strength permits.
*When shock is profound and when exhaustion is marked it is better to limit
the operation to relief of the constriction and formation of an artificial anus.*
In performing resection and suture especial care must be taken to pre-
vent a general infection, inasmuch as the field of operation is extremely
septic. (See Intestinal Resection and Suture.) In favorable cases the
prognosis is encouraging, there being probably 50 per cent. of recoveries.
The formation of an artificial anus is attended by unusual difficulties in

gangrenous hernia, because both proximal and distal openings must be fastened into a septic wound. The bowel ends must be securely united to the skin, and drainage must also be used to prevent a general infection. Moreover, this operation must be followed by secondary resection and suture. The formation of an artificial anus, therefore, is not very much safer or easier than complete resection and suture, though it may be more rapidly performed. In case of extreme need the necrotic loop may be rapidly excised and the bowel ends stitched hastily to the skin ; or the gangrenous loop may be simply incised after division of the ring, the coil being held in its position by adhesions. Resection, on the other hand, demands a careful suturing of the approximated bowel ends, an operation which requires at least half an hour even in the hands of the most skilful.

The mortality of artificial-anus formation is high, not from the operation, but from the profound systemic depression which indicates that procedure. General anæsthesia adds a serious danger when the patient is collapsed and vomiting. Many deaths on the table during herniotomies are due to strangulation from gastric regurgitation. If general anæsthesia is used it must be sparingly administered and carefully watched. (See Peritonitis, Intestinal Resection, etc.)

Intestinal obstruction persisting after herniotomy should suggest a reduction *en bloc* (Fig. 188) or a twist in the intestinal loop. The former accident, occurring not infrequently after taxis as well as herniotomy, is caused by a forcible replacement of the gut, constricting ring and all, inside the abdominal cavity. *Reduction en bloc* is not likely to occur after complete division of the ring : it may take place when the incision is made blindly with the probe-pointed bistoury deep upon the finger. Careful digital exploration will demonstrate whether or not the relief of the constricting ring has been complete.

Obstruction from a *twist* is extremely rare. It cannot be prevented, and can be demonstrated only by secondary exploration. Acute obstruction may persist as the result of faulty adhesions.

Necrosis of the intestinal mucosa with subsequent contraction and stricture may cause, ultimately, a chronic obstruction. Stenosis at the line of suture rarely follows enterorrhaphy. (See Intestinal Resection.) Pseudo-ileus, due to paresis of the muscular coats, is not infrequently observed.

THE RADICAL CURE OF HERNIA.

The present methods for the radical cure of hernia have entirely supplanted the earlier operations, which were clumsy. ineffectual, and dangerous.

The principal early methods were—
1. Injection of irritants in the neighborhood of the pillars and rings ;
2. Irritation from the pressure of plugs ;
3. Subcutaneous wiring and suture.

The extensive experience of the past few years with the cicatrices resulting from abdominal wounds has shown that scar-tissue under persistent pressure stretches and gives way, and that a large percentage of ventral herniæ results. Hence the inefficiency of the granulation method (McBurney's), a method in which it was expected that after excision of the sac high up, and suture of the skin to the muscular layers, healing from the bottom, induced by packing the wound with gauze, would ensure a cicatricial barrier that would not give way.

Careful observations after long periods of time have proved that these operations

are followed by a large percentage of relapses; and though perhaps sufficient time has not elapsed to ascertain the ultimate results in the later operations, there seems no doubt that the improvements in the mechanical operative technique of the radical operations of the present day will lead to better results than were attained in the operations of the past.

The present methods of radical cure are all carried out after thorough exposure of the field by careful dissection. The sac is either isolated and removed or used as a wad to fill the ring (Macewen's). The pillars of the ring are sutured, or the spermatic cord, after removal of the sac, is transplanted to a new and artificial ring after closure of the inguinal canal and the external ring.

The best methods of operative cure depend upon perfect asepsis: without it all methods fail. They require also extensive dissections of the whole field, with exposure of the inguinal canal and rings, with isolation and removal of the sac well above the constricting ring, and with as perfect obliteration as possible of a protruding peritoneal pouch. They require, finally, restoration of the divided layers of the abdominal wall with obliteration of the former canal by buried sutures, and with provision of an artificial channel for the spermatic cord.

At the present time two methods for the radical cure of inguinal hernia are to be preferred, that of Bassini and that of Halsted.

Bassini's Operation.[1]—" 1. The *external incision* begins at a point nearly or quite on a level with the anterior superior spine, continues obliquely down parallel to and about half an inch internal to Poupart's ligament, and ends at the centre of the external ring.

2. The incision is rapidly carried down until the aponeurosis of the external oblique is freely exposed for a distance of two and a half to three inches; a director is then passed through the external ring just beneath the aponeurosis, and the aponeurosis is divided well above— *i. e.* a half to one inch above the internal ring.

3. The cut edges of the aponeurosis are held up with forceps and dissected free from the underlying muscles as far as the edge of the rectus, internally and externally, until the shelving portion of Poupart's ligament has been clearly exposed.

4. The sac and cord are then isolated *en masse*, and this is best accomplished with the fingers and blunt-pointed curved scissors. If the peritoneal layer of the sac is first reached, the dissection is easy, rapid, and bloodless.

5. The cord and its vessels are now separated from the sac, and this, too, is best done with the fingers. The separation is carried high up within the internal ring, and the sac is opened and its contents examined. If adhesions are present, they are separated; omentum, if thickened, is excised, and the contents are reduced into the abdominal cavity. The sac is then ligated or sutured above the internal ring, where it merges into the general peritoneal cavity.

6. The cord is held up and the edges of the aponeurosis rolled back, while from three to five buried sutures are introduced beneath the cord. These are best introduced from within outward, and should include the internal oblique and transversalis muscles, the transversalis fascia (and sometimes the edge of the rectus) on the inner side, and the deep shelv-

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[1] "Ueber die Behandlung des Leistenbruches," von Ed. Bassini, *Archiv f. klin Chir.*, Bd. 40, 429, 1890, quoted by Bull and Coley in the article on Hernia in *System of Surgery* by F. S. Dennis, vol. iv. p. 184.

ing portion of Poupart's ligament on the outer side. The lowermost suture should embrace the conjoined tendon.

7. The cord is now replaced, and the cut aponeurosis is closed over it by means of a continuous suture extending as near the pubis as possible without causing undue constriction of the cord.

8. Closing the skin-wound with interrupted sutures, without drainage, completes the operation (Figs. 189, 190, 191).

Fig. 189.
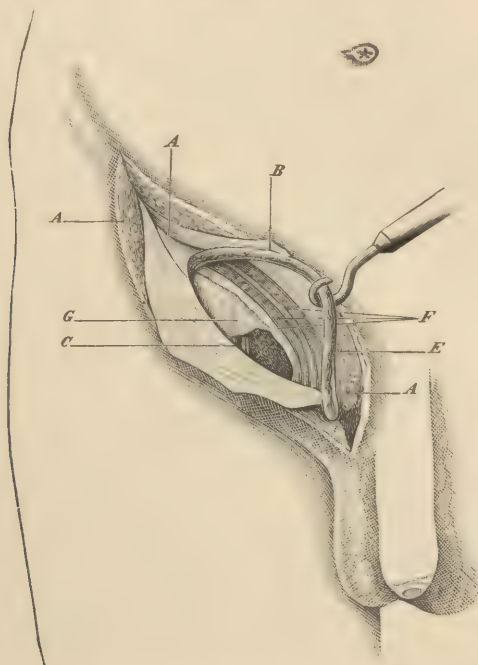
Bassini's method of operation for inguinal hernia : *A, A, A,* subcutaneous fatty tissue ; *B,* upper portion of the divided aponeurosis dissected from underlying structure ; *C,* under portion of aponeurosis of external oblique ; *E,* cord ; *F,* 1, internal oblique muscle ; 2, transversalis ; 3, fascia of Cooper (Bull and Coley, *loc. cit.*).

Bassini at the time he published his paper (1890) had operated upon 262 cases of inguinal hernia, with but 1 death and but 7 relapses. All but 4 of his cases had been traced (Bull and Coley).

Halsted's method consists in the following steps :

1. An oblique incision is made by which the external abdominal ring is thoroughly exposed.

2. An incision 3 cm. long is made through the aponeurosis of the external oblique, and through the internal oblique to the internal abdominal ring. The external oblique is incised parallel with its fibres ; the internal oblique is divided at right angles to its fibres (the line of incision deviating from, not parallel to, the previous incisions through skin and aponeurosis of external oblique). The incision in the external oblique should be parallel with its fibres.

3. The prolongation of the fascia transversalis (tunica vaginalis

propria funiculi spermatici), which includes the cord, is first split with a knife and then torn.

4. The larger bundle of veins is separated from the vas deferens with as little disturbance to the vas deferens as possible. The larger bundle of veins is excised from the external to the internal ring; the smaller veins accompanying the vas deferens are left undisturbed. In children the veins should not be excised. It is usually advisable to

Fig. 190.
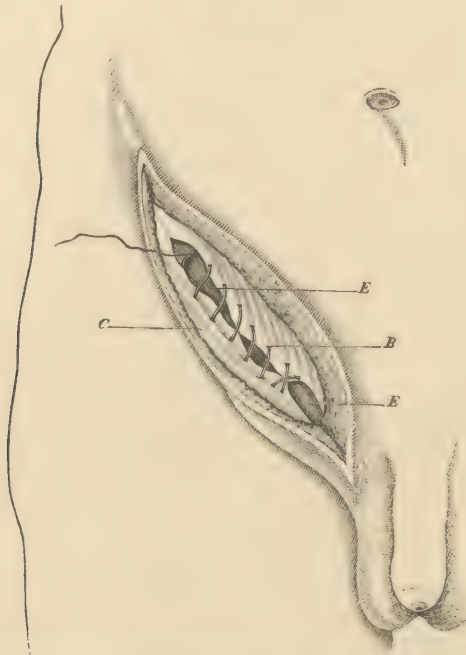
Bassini's method of operation for inguinal hernia: the end of the third step of the operation. The cord has been transplanted and the musculo-aponeurotic tissues on the inner side have been sutured to Poupart's ligament (*D*) on the outer side (interrupted sutures are usually employed) (Bull and Coley).

excise the veins in adults, unless they contribute but little to the size of the cord.

5. The sac is isolated, opened, transfixed, and tied with one or more sutures, cut off, and the stump dropped into the abdomen.

6. The vas deferens should now be transplanted to the outer angle of the muscle wound; the muscle flaps are brought down with forceps so as to enable the operator to include them in all the sutures, except one or two. The vas deferens should be snugly embraced between, but not constricted by, the two outermost stitches (Figs. 192, 193).

The muscular and tendinous layers of the ring and abdominal wall are carefully sutured, layer by layer, with Halsted's quilted suture; the material used may be silk, animal tissue, or silver wire. The wound is closed without drainage. The stages of the operation are shown by the diagrams.

Fig. 191.
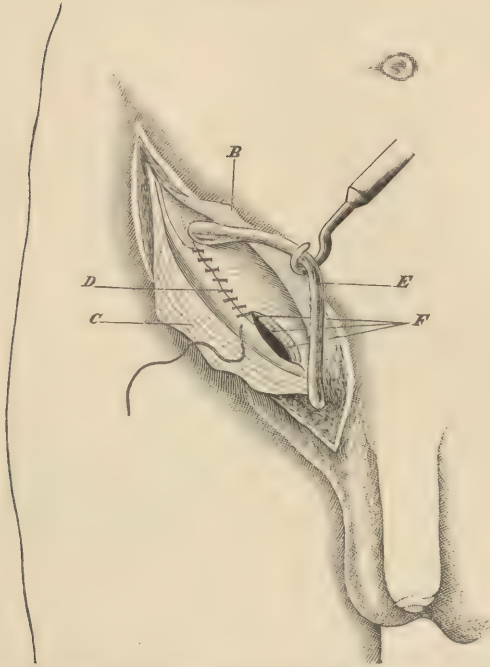
Bassini's method of operation for inguinal hernia: fourth step. Suture of the divided apo-
neurosis over the cord with a continuous suture (Bull and Coley).

The results by Halsted's method, up to April 1, 1896, are extremely encourag-
ing. Of 130 cases, 110 have been under observation since the operation, 20 have

Fig. 192.
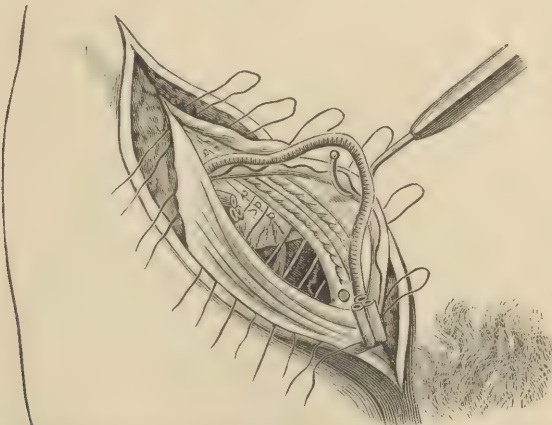
Halsted's operation for inguinal hernia: first step (Bull and Coley).

been lost sight of. There has not been a single real recurrence. With the excep-
tion of 5 cases all are perfectly healed. There is not the slightest protrusion or
unnatural impulse on coughing. Five cases cannot be called absolutely perfect

cures, though in but 1 of the 5 cases was there a complete, undoubted recurrence from stretching of the scar.

The use of silver wire instead of silk has been followed by more perfect recoveries than were seen in the earlier cases, there having been but one case of suppuration in two and a half years.[1]

FIG. 193.

Halsted's operation for inguinal hernia: second step (Bull and Coley).

Recurrence after Operation for Radical Cure of Inguinal Hernia.—Under modern methods recurrence after operation for radical cure has become infrequent, though it remains to be seen whether the results will still be as good after the lapse of years.

FIG. 194.
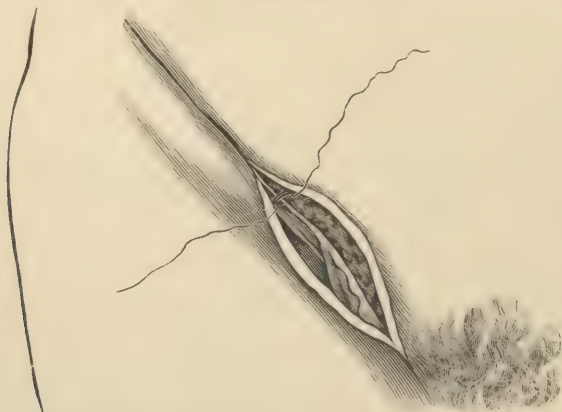
Halsted's operation for inguinal hernia: third step.

Predisposing causes of recurrence are—the giving way of stitches, the use of drainage, septic infection and healing by granulation, advanced age of the patient, the large size of the hernia, relaxation of scar, fatty abdominal wall, etc.

[1] Personal communication.

Treatment for the Cure of Inguinal Hernia in the Female.—This consists in excision of the round ligament and hernial sac, and obliteration

FIG. 195.
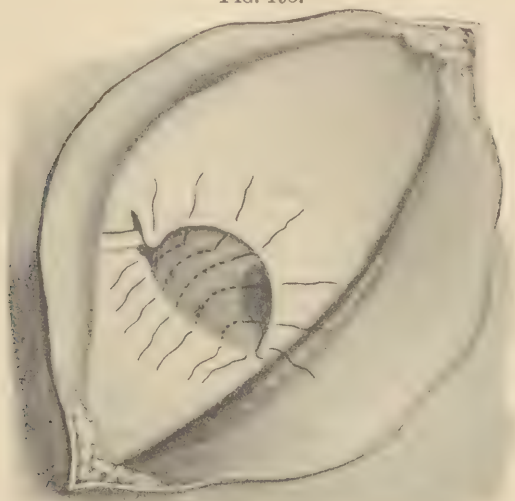
Femoral hernia, radical cure by Bassini's method : sutures in position.

of the canal by the same method of buried suture employed in the cure of inguinal hernia in the male. Recurrence is extremely infrequent.

The Radical Cure of Femoral Hernia.—Bassini's method is the

FIG. 196.

Bassini's method of radial cure of femoral hernia : suture tied.

best. It consists in an incision just below and parallel to Poupart's ligament, with its centre over the hernial tumor. The sac should be exposed, freed as high up as possible, opened, its contents examined and reduced into the abdominal cavity. The obliteration of the pouch should

be attempted by high ligation and removal of the sac. The structures of the femoral canal, the falciform, crural, and pectineal fasciæ, Poupart's and Gimbernat's ligaments, must be carefully identified and approximated by buried sutures. The femoral canal may be closed by four or five sutures uniting the falciform edge of the fascia lata to the pectineal fascia. The femoral ring should be closed by three sutures, uniting Poupart's ligament and the pectineal fascia in a line from the pubic spine to the pectineal eminence. The external wound should be closed without drainage. (For stages of operation for Radical Cure of Femoral Hernia, see Figs. 195, 196.)

TREATMENT OF UMBILICAL HERNIA.—The treatment of umbilical hernia in adults should be operative in almost all cases, because of the extreme difficulty of retaining the hernia within the abdominal cavity by any form of truss, and because of the danger of inducing inflammatory changes by any form of mechanical treatment. The operation for radical cure consists in making a long incision around the tumor, including the umbilicus and a large part of the hernial covering. This incision should open the sheath of the rectus on either side. After the hernial sac has been opened its contents should be carefully examined for coils of intestine, which should be reduced into the abdominal cavity. Prolapsed omentum should be ligated and removed. Adherent and necrotic portions of the intestine should be treated as in any form of hernia. After the sac has been emptied of its contents, it should be dissected free from surrounding structures, all redundant portions removed, and the edges carefully sutured together. The muscular bellies of the recti should then be approximated by buried sutures, and the external and superficial structures of the wound closed without drainage.

Ventral herniæ may be operated upon for radical cure in the same manner.

CHAPTER X.

DISEASES OF THE RECTUM AND SIGMOID FLEXURE.

By Charles B. Kelsey, M. D.

Before taking up the different affections of the rectum in detail a few words of a general character may be useful.

The diseases of the *rectum itself*—that is, those which are confined to the lower six inches of the intestine, or even to the rectum and sigmoid flexure—are easily enumerated. The diseases *outside* of the rectum itself which by pressure or nervous influence or propinquity will cause symptoms in the rectum, particularly painful or irregular defecation, are many. The two classes of cases must be equally understood before much success can be hoped for in the treatment of the rectum alone; for if there is any disease of any organ in the male or female pelvis which may not cause pain in the rectum and simulate some disease of the rectum itself, the writer fails for the moment to recall it. In many such cases the rectum will be found normal on examination; in others some palpable affection, as hemorrhoids, may be found, but treatment of these will entirely fail to give relief.

Congenital Defects.

Congenital defects consist, for the most part, of forms of more or

Fig. 197.
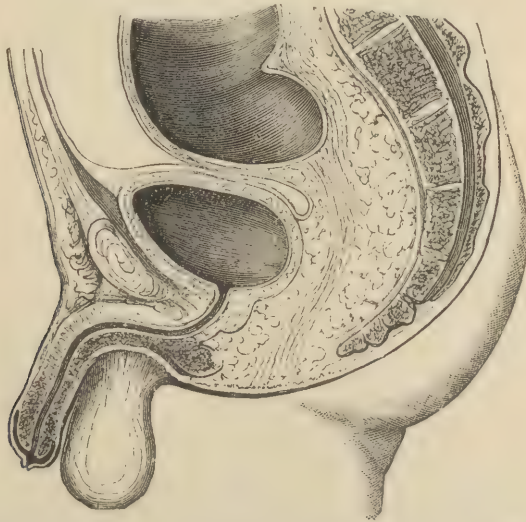
Congenital absence of anus, rectum terminating by a cul-de-sac (Potherat).

less complete *absence of the rectum* or *imperforate anus*, which are better illustrated in the accompanying illustrations than described by words.

FIG. 198.
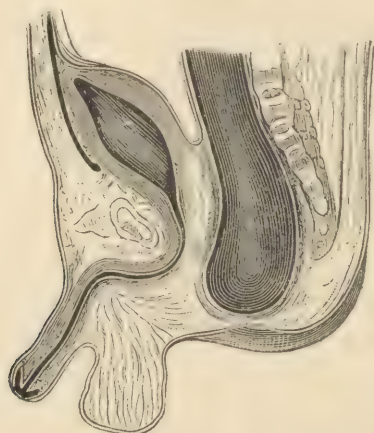
Same as Fig. 197.

They all cause symptoms of obstruction of the bowels unless speedily recognized and relieved.

FIG. 199.
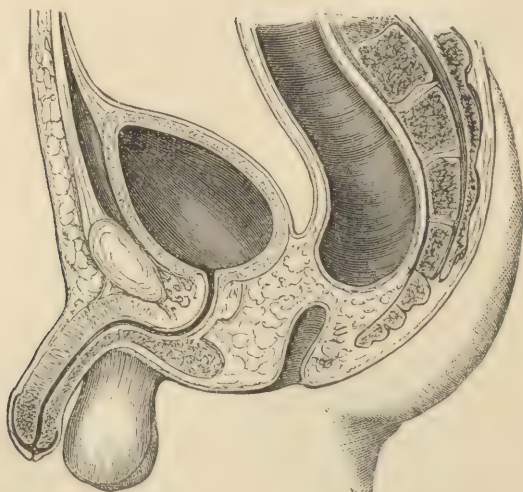
Congenital defect of rectum: ano-rectal obliteration (Potherat).

When a new-born infant has failed to soil its diaper within twenty-four, or at most thirty-six, hours, a careful examination with the little finger or with a catheter should be instituted. Should this reveal the condition or should the urine be stained with fecal matter, immediate anæsthesia and operation—depending upon the local condition—are imperative. If after careful exploration with knife, finger-tip, and

sound no trace of rectum be discovered, it will be better to do a colos-
tomy (see below) than trust to further search at the pelvic outlet.

Fig. 200.

Same, rectum opening into bladder (Potherat).

Fig. 201.
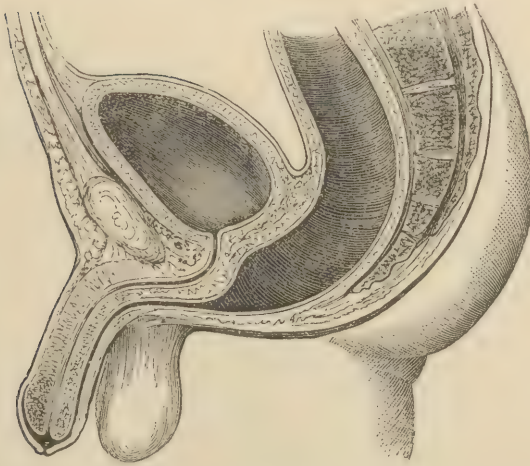
Rectum terminating by continuation into the penis (Potherat).

These conditions are always serious, too often fatal. They are rare,
but urgent when present.

HEMORRHOIDS.

The most common of all the diseases of the rectum is **hemorrhoids**,
and there is perhaps no better classification of them than the old one of
external and *internal*. By an external hemorrhoid is meant one which

arises from the margin of the anus *outside the external sphincter muscle.* It differs absolutely from the internal variety in the fact that it is always composed either of skin and hypertrophied connective tissue, forming a mere cutaneous tag, or else is composed of a clot of blood extravasated from a small cutaneous vein. *Internal* hemorrhoids, on the contrary, although composed in great measure of enlarged veins, have a very free arterial supply, and are a mere collection of enlarged blood-vessels bound together by hypertrophied connective tissue and covered by the natural mucous membrane of the rectum. An internal hemorrhoid is, moreover, an affection of the middle hemorrhoidal veins and arteries, which are parts of the visceral system and not of the cutaneous blood-supply.

Internal hemorrhoids may also, with advantage, be divided into two classes. In one there is the large *prolapsing tumor,* generally recognized as a pile by the profession and laity alike. In the other we find the *flat, strawberry-like* surface, raised only slightly above the surrounding healthy mucous membrane, closely resembling nævus in anatomical structure, and causing no symptoms except those which come from the frequent and often excessive loss of blood.

Without going at all into the pathology or symptomatology of this very common and simple affection, which lack of space forbids, we will at once consider what is of most practical interest—the treatment.

The TREATMENT of internal hemorrhoids may be either *palliative* or *radical.*

For palliative measures we have careful attention to diet to secure regularity in defecation, attention to the general health, and the free use of cold applications to the mass when protruding after stool. For *bleeding* we have the dry subsulphate of iron, which may be lightly sprinkled over the tumors when extruded, or used in a suppository, one grain at a time. This is apt to cause considerable smarting pain.

Small bleeding tumors may be completely cured by touching them two or three times with strong nitric acid; and a very severe hemorrhage may sometimes be stopped for a long time by this simple method, even where there is no hope of a radical cure. But in large, old prolapsing tumors the free application of acid to the surface will only cause additional pain.

The *injection of carbolic acid* in some medium, such as glycerin and water, is also a palliative measure which has had great notoriety. It is attended by a chain of accidents which make its use very uncertain, and in many cases unsatisfactory. There are great pain, swelling, the formation of pus, and sloughing.

In any large number of trials some of these results are sure to follow, to the disgust of both patient and physician, while the relief obtained by the method, even in the cases which escape these accidents, is but short.

The radical or operative treatment of hemorrhoids consists in their removal in any one of many ways, all of which involves the use of an anæsthetic and more or less confinement to bed, as after any surgical operation. Of these only a few will be considered.

In small tumors, where there is little to tie or clamp, and perhaps where there is no protrusion at stool, and yet free bleeding and all the other symptoms of hemorrhoids, an exceedingly effective means of cure

is *punctate cauterization.* The sphincters should be well dilated, a Sims rectal speculum introduced, and the tip of the Paquelin cautery at a dull red heat inserted into the substance of the tumor.

The writer often does this to the small varicosities which will sometimes remain after an operation with the clamp or ligature. It is often the case that after several very large masses have been tied or clamped off there will still be one or perhaps two small spots which seem hardly big enough to call for another application of the clamp, and yet which the operator does not like to leave. A single touch with the cautery solves the difficulty; and it is to small tumors of this size that the method is most adapted, although the French have advocated it in all cases, large or small, requiring operation; and it is effective.

Whitehead's operation consists in removing the mucous membrane from the lower inch of the rectum in a cylinder, and with it the hemorrhoids. There is no essential difference between it and the so-called " *American operation,*" except that in the former the first incision is made in the line of junction of the skin and mucous membrane, and the dissection carried upward, while in the latter the first incision is made inside the rectum above the hemorrhoids, and the dissection carried downward.

The objections to it are—the time necessary to perform it; the fact that no such elaborate operation is ever necessary to cure any case of hemorrhoids; and the liability to two accidents—first, the production of a *stricture* from failure to get union, and, second, the *eversion* of the mucous membrane caused by pulling it down and attaching it to the skin. Both of these results are now sufficiently frequent, and the number of secondary operations necessary to cure patients of the effects of the " American" operation is increasing.

Between *Allingham's operation* by *ligature* and *Smith's operation* by *clamp and cautery* there may not be much to choose. Both are safe and both are radical, and either is quickly performed without profound anæsthesia or loss of blood. And yet for many years the writer has practised the latter in preference to the former, because in his hands it causes less pain, shorter convalescence, and less reflex vesical disturbance. This is explained by the fact that a ligature around the pedicle of a pile often includes in its grasp a nerve as well as an artery, and hence causes pain until it comes away.

The *clamp-and-cautery operation* is done as follows : The patient is etherized and placed in the lithotomy position. The sphincter is thoroughly stretched without rupturing the muscle. Time should be given to this, and when the stretching is completed the anus should be patulous and without contractile power. Such paralysis will last two or three days only.

After the stretching, the hemorrhoids, if of any size, will protrude, and the largest is seized with volsellum forceps and pulled gently still farther out from the anus. Its attachment is then cut through on the cutaneous margin with scissors. This cutting is done where the skin becomes continuous with the mucous membrane, and is intended simply to avoid including skin in the grasp of the clamp. Where the hemorrhoid does not rest upon the muco-cutaneous junction, and the clamp can be applied to its base without including any skin, no cutting around the pedicle or base is necessary.

In the incision thus made the clamp is applied, care being taken to include all that remains of the stump in its grasp, so that when the

pile is cut away none of its blood-vessels shall be outside the grasp of the instrument. The blades of the clamp should lie along the axis of the gut, and the stump when released from the grasp of the clamp should be in the line of the radiating folds of the anus, and not across them.

No force is necessary in using the clamp. It is not a crushing machine, to be screwed down as tightly as possible. In most cases it would answer its purpose as well without the screw attachment, and in those most recently manufactured this is left off. It is merely a temporary hæmostatic forceps to hold the stump after the pile has been cut off till the cautery can be applied to the cut surface. The only advantage of the screw attachment is that sometimes the cautery may not be ready, or the operator may have to attend to the anæsthetic, or may be interrupted for a moment, when, with a turn of the screw, the clamp may be left in position for any length of time.

Having grasped lightly the pedicle in the clamp, the pile is cut away *at a sufficient distance from the clamp to leave a good thick stump for cauterizing.* This is the important point in the whole operation. If the pile is shaved off close down to the clamp, there will be no room to cauterize the cut vessels and firmly close their mouths, and the moment the clamp is relaxed they will bleed. There should be stump enough left so that the cautery at a dull red heat can be passed over its cut surface again and again till it is thoroughly charred, and a good thick eschar remains. The clamp is then gently relaxed, and if any vessel spouts, it can be closed and the cautery again used on that point; but if the eschar remains dry, it is allowed to slip from the grasp of the clamp and is gently pushed up into the rectum.

Even in the cases of most extensive disease there will seldom be more than three large individual hemorrhoids, springing from different points in the circumference of the anus, and hence more than three applications of the clamp are seldom necessary. When one mass has been removed, a little care should be exercised in removing the second and third, so that a distinct strip of mucous membrane may be left between the eschars, otherwise too much contraction may follow cicatrization. Half an inch of membrane at three different points in the circumference will be found amply sufficient. If any small varicosity be found in these intervening spaces, puncture with the cautery as described will always be efficient to prevent their future development.

After the operation there will always be some bleeding from the scissor-cuts made in the skin for isolating the pedicles; this is stopped by pressure of a pad and T-bandage. There should never be any hemorrhage from the eschars or from the cavity of the rectum. After a few hours the pad and bandage may be replaced by a hot poultice. The patient is allowed to stand and pass water; no restriction is made as to diet; his bowels are moved by a laxative forty-eight hours after operation, and kept open every day or second day afterward. Straining and pain in defecation are best relieved by an enema of lukewarm water when the laxative is about to have its natural effect. Patients usually sit up on the second or third day, and leave their rooms by the end of a week, although complete healing cannot be expected in less than three weeks.

After years of experience with this operation the writer can only say he has never had an accident, never had to use a catheter, seldom had to give morphine, and confidently expects a rapid and uneventful recovery in every case. But accidents have occurred, though the fault has generally been with the operator and not the method. Only recently has

it happened to me to have a distinct case of secondary hemorrhage on the third day after this operation; but, as this is the only one I have ever seen, and as I happen to know of several after the ligature, my opinion of its value is unchanged.

Rectal Polypi.

Polypoid tumors are frequent in the rectum, especially in young children. They are of the myxomatous or adenomatous type or of mixed form, and vary much in size and number. Widespread polypoid disease is represented in Fig. 202. Sometimes they bleed easily. They are occasionally presented for inspection at or after stool, and may require replacement or reduction like certain piles. They cause, for the most part, *symptoms of rectal malaise and tenesmus.* Children who are frequently impelled to stool should be carefully examined—if need be under anæsthesia—to discover polypi if present. These tumors are often pediculated, sometimes by long stems which are elongated by natural efforts at their expulsion. In such a case they may be twisted off. In other cases, when they are more sessile, their careful enucleation or destruction may be required.

Aggravated instances are known in which straining efforts, long continued and often repeated, have produced invagination with all its disastrous consequences.

Prolapse and Invagination.

There are *two* varieties of prolapsus, to be carefully distinguished from each other in practice. The first is composed of *mucous membrane only* (Fig. 203); the second, of *all the coats of the bowel*, and hence, when of sufficient extent, containing peritoneum.

The first is a mere everting of the mucous membrane, rendered possible by the laxity of the submucous connective tissue. The second is an exaggeration of the first, in which, after the connective tissue has yielded to its utmost, the whole thickness of the rectum begins to protrude. It follows, of necessity, that after this protrusion has reached a certain point the peritoneal coat must also protrude through the anus.

The first form of prolapse is seen frequently in *children* as a result of weakness, diarrhœa, or any irritation of the rectum which produces tenesmus. It is also seen in adults, generally as a result of weakening of the sphincters. It is a minor affection, and in all cases easily curable by surgical measures. The importance of distinguishing between it and the second variety at once becomes manifest when it is stated that

Fig. 202.

Multiple polypi of rectum
(Potherat).

treatment adapted to it may easily result fatally when applied to the second.

A serious and not very rare complication of the second form of prolapse arises from the fact that the pouch of peritoneum contained in it *may be the sac of a hernia*, and may contain coils of small *intestine*, an *ovary*, or the *bladder*. Usually the peritoneal pouch will be found on the
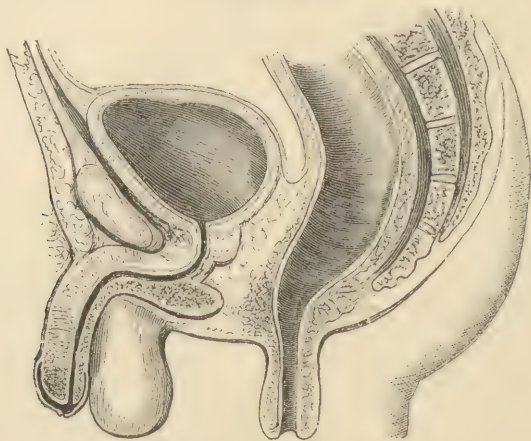
Partial prolapse of rectum (Potherat).

front of the prolapse, but it may be both in front and behind, and, when intestine is contained in it, it may be reduced as in any other variety of hernia.

The fact that in old cases of the second variety of prolapsus the gut is generally chronically inflamed, and hence weakened, and may easily tear or rupture, allowing the escape of small intestine through the rent and out of the anus, has given rise to many recorded cases of so-called *rectal hernia*—protrusion of small intestine through the anus—sometimes to the extent of many feet. It is doubtful whether the healthy rectum ever ruptures as a result of any ordinary violence, and the great majority of these cases are due to the existence of an old prolapsus containing coils of small intestine.

There is one remarkable case on record, however, in a boy of thirteen, in whom, as a result of the fall upon him of a cart, a considerable part of the small intestine was forced out of the anus. The most remarkable part of the case is that, after the intestine had been replaced and had protruded again several times, and had become gangrenous, fifty-seven inches of it were cut off and the boy made a good recovery. This was in 1755, and shows what may happen without antisepsis.

It is a mistake to suppose that the second form of prolapse is not met with in children, for it is only an exaggerated form of the first. It is distinguished from it, first, by its *size*, being from its nature of very considerable dimensions. The first form is not thick to the feel, the folds of mucous membrane radiate from the orifice to the circumference, and the opening is circular and patulous. In the second the orifice is slit-like, and is drawn backward by the attachment of the

meso-rectum, or, in females, forward by the closer attachment to the vagina. The form of the tumor is *conical ;* its walls are *thick* and firm ; and when pressed by the fingers the gurgling of gas in a contained loop of intestine may sometimes be felt. Such a tumor may also be resonant on percussion.

The TREATMENT of prolapse is both general and surgical. In *children* a *polypus* should always be looked for, and removed if found, as this is a very frequent cause of the condition. The same rule applies to calculus, phimosis, constipation, and pin-worms. The general health should be carefully attended to ; the tumor when down should be washed with an astringent solution and replaced ; and the child should be made to have its passages in bed, while the buttocks are held together by a nurse.

Many cases of prolapse are due to the carelessness of nurses in putting small children upon the chamber and allowing them to remain there and strain.

Should these measures fail, *Van Buren's operation* with the cautery can always be relied upon to cure in prolapse consisting of mucous membrane alone.

With the child under ether the pouting mucous membrane is seized with forceps and gently pulled out of the anus. Successive pairs of forceps are used on opposite sides of the anus till the whole amount of the protrusion is in sight. With the cautery at dull-red heat three, four, or even six stripes are drawn on the tumor, commencing at the apex and radiating toward the orifice. The cauterizations should extend only through the mucous layer, should be light at the apex, and should gradually increase in depth as they approach the sphincter. After a sufficient number of these linear cauterizations have been made at equal distances from each other on the circumference of the tumor, the whole mass is reduced.

The *after-treatment* is of scarcely less importance than the cauterization. A firm graduated compress should be applied over the anus and secured by broad strips of adhesive plaster, which also draw the buttocks firmly together. Opium and chalk or some other astringent should then be given by the mouth to keep the bowels from moving for a week or ten days, if possible. The first passage should be assisted by an enema of water, and should be had with the child in bed and a nurse pressing the buttocks together to prevent protrusion. For at least a fortnight this rule should be carried out.

Occasionally it may be necessary to repeat the cauterization a second time, but this treatment will seldom fail in any case of prolapse of mucous membrane alone, where it is thoroughly carried out.

In *prolapse of the second variety* this treatment will also often be found efficacious. It may also be made more radical by burning through the sphincter at two or three points. The idea of the radiating cauterizations through the mucous membrane is simply to bind it and the submucous connective tissue to the muscular coat by linear cicatrices. In more extensive disease the orifice may also be reduced in size by *burning through the sphincters,* thus causing a slight degree of constriction at the anus.

But in many of the old and extensive cases of the second variety

this plan of treatment will fail, and we are then forced to more radical measures.

One of the best of these is *amputation of the entire tumor* after the method of *Mikulicz.* The patient is placed in the lithotomy position. Two strong threads are passed through the extremity of the prolapse for fixation. A transverse incision is made through the anterior part of the prolapse till the serosa is exposed. The serosa of the outer layer is then stitched to the serosa of the returning portion, thus closing the peritoneal cavity. Just outside this row of sutures the anterior part of the returning cylinder is also cut across, and the two divided ends of the gut are then sutured with silk through the whole extent of the incision, the threads passing through all the coats and being left long for guides till the completion of the operation. Next the remaining portion of the periphery is cut across in the same way, the mesenteric vessels tied, and the suturing completed as in the anterior lip. All sutures are cut short and the stump of the prolapse reduced.

The occurrence of a *circular slough* as a result of the strangulation of a prolapse is always a very serious complication. The tumor is generally of the second variety ; has become first irreducible, then strangulated, and at the apex, around the opening, there will be seen a black ring of dead mucous membrane and connective tissue of greater or less extent.

The gravity of this condition consists in the fact that the circular slough may cause a severe stricture after cicatrization has occurred, and the longer the prolapse the higher up the bowel will the stricture be after it has been reduced.

The TREATMENT of this condition resolves itself into the ablation of the tumor by the method just described.

The essential *difference* between *prolapsus* and *invagination* is that the former is a mere everting of the mucous membrane, and perhaps of the other layers, of the rectum, beginning always at the verge of the anus and gradually increasing in size as more and more of the gut protrudes from the body ; while the latter is a *telescoping* of one part of the gut into the part below, and may begin anywhere in the length of the tube. A prolapse necessarily protrudes from the anus ; the invaginated portion of bowel may or may not do so, depending upon its length and location.

When an invaginated portion of the bowel appears at the anus, it can always be distinguished from a prolapsus by the presence of a groove or sulcus between the enclosed and enclosing portion, or, in other words, between the intussusceptum and the intussuscipiens. The bottom of this sulcus, or what is technically known as the neck, may be reached by a finger in the rectum or by a long bougie, or it may be much higher up the bowel. It is evident that a cross-section through an intussusception will divide three distinct layers of gut in their entire thickness— the enclosing, the entering, and the returning portions. In the sulcus between the enclosing and the entering cylinders two mucous surfaces are in contact ; in the sulcus between the entering and returning cylinders two serous surfaces are in contact.

Of this condition there are many varieties and degrees. The most common (forming nearly one-half of all the cases) is the *ileo-cæcal,* or that in which the ileum and the cæcum pass into the large intestine, carrying the ileo-cæcal valve at the apex. This variety is apt also to be the most extensive, the cæcum passing sometimes the whole length of

the colon and appearing with its valve and the appendix outside the anus. The next most frequent variety is that involving the *small intestine ;* and after these in frequency come the cases affecting the *colon, sigmoid flexure,* and *rectum.* When the large bowel is affected it is most often near its termination, the descending portion passing into the sigmoid flexure, the flexure into the rectum, or the upper part of the rectum into the lower. These latter forms are necessarily limited in length, for when once the invagination has been fairly formed, and after the entering portion has been grasped, the increase in length is always at the expense of the sheath.

The apex or point where the entering portion becomes the returning portion remains constantly the same, and the turning in is not done at this point, but at the neck. If, therefore, the neck be within the rectum, the intussusception must be limited by the length of the rectum remaining between the neck and the anus, and must be correspondingly short.

An intussusception of the rectum or sigmoid flexure will also, as a rule, be straighter and less curved than one of the bowel higher up, because of the absence of the mesentery in the tumor. As the involution goes on at the neck of the tumor the mesentery is drawn in between the two inner layers in the form of a cone with the base upward. The traction upon this causes a curve of the contained cylinder, the concavity of which is toward the attachment of the mesentery. In the small intestine this curve is very marked at times, and the mesocolon may cause the same appearance in cases involving the large bowel. The traction of the mesocolon may also cause other changes. The axis of the contained portion is not the same as that of the sheath, and the orifice is drawn into a slit-like shape and turned against the side of the sheath, so that it may be difficult to detect it with the finger.

The obstruction and the strangulation of the contained portion may cause certain changes. The bowel above the implicated part may be simply *distended* and congested, it may be *filled* with fæces, or it may be ulcerated and *perforated.* The serous surfaces in apposition in the two contained portions are apt to become united by adhesions. When present and extensive these constitute the chief obstacle to reduction, whether spontaneous or the result of treatment.

As a result of strangulation of the contained portion its walls may become much swollen by transudation of serum, the peritoneum congested, the mucous membrane infiltrated ; blood is effused between the mucous surfaces of the outer and middle layers ; and the whole contained portion becomes in this way irreducible. Should *strangulation be sufficiently severe, gangrene* may supervene, and this is Nature's method of cure. It is more apt to take place in acute than chronic cases, and may involve the whole or part of the contained portion. As a result, many feet of bowel may slough off and be passed, either in small portions or in large cylinders.

The TREATMENT of intussusception consists, first, in gentle efforts at reduction. The mass must be replaced by a process exactly the reverse of the one by which it came down, the most dependent portion being first carried into the body, and the telescope unfolded in this way. This means failing, a reduction may be accomplished by laparotomy, or a gangrenous portion may be exsected, or an anastomosis established around the involved part. The operation of *excision with circular enterorrhaphy,* as described under Prolapsus, may also be curative in old and chronic cases.

Chronic invagination of the sigmoid flexure into the rectum, lasting for many years, is a condition quite frequently diagnosticated, but seldom seen. The writer has always believed, theoretically, that it might occur and might cause a peculiar train of symptoms, but has never seen an undoubted case till within the past year. Usually the cases turn out to be simple ones of very obstinate constipation attended with great mechanical difficulty in obtaining a movement of the bowels, and possibly with slight prolapsus and obstruction of the anus from crowding down of the normally profuse folds of mucous membrane. A positive diagnosis of invagination can only be made when the condition can actually be felt by digital examination, as the symptoms cannot be distinguished from those of old cases of severe constipation.

In the case referred to, however, the sulcus between the intussusceptum and intussuscipiens was well marked, soft, movable, and not to be mistaken for an organic stricture. Under ether the invaginated portion was drawn three inches out of the anus, while the ring could still be distinctly felt two inches within the sphincters.

A combined operation was done. First, the anus was tightened by four applications of the cautery to the sphincter, causing a slight amount of artificial stenosis. Second, the abdomen was opened by the usual incision for colostomy. The sigmoid flexure was drawn upward into the wound to its utmost extent, and stitched as securely as possible by five silk sutures passed through one of the longitudinal bands and the abdominal wall, as in a ventral fixation of the uterus. For two weeks the patient was compelled to have his passages in the recumbent position. After that he was allowed to leave the hospital. Six months after the operation there had been no return of the disease.

In one other case of prolapsus of very extensive proportions, due to locomotor ataxia, I have repeated this operation with equally good results.

ABSCESS AND FISTULA.

Abscesses around the rectum are best divided for clinical study into *superficial* and *deep*. By the former are meant those of the subcutaneous cellular tissue, which are generally of trifling importance, often break and heal spontaneously without the formation of fistulæ, or, when resulting in fistula, leave one of the superficial and trivial variety easily curable by incision.

The *deep abscesses* may be divided with advantage into those of the *ischio-rectal fossa* and those of the *superior pelvi-rectal space*, two anatomical regions whose relations are important. An abscess of the *ischio-rectal fossa* is below the levator ani muscle and outside of the pelvic fascia which covers that muscle, and separates the ischio-rectal region from the general pelvic cavity. An abscess of the *superior pelvi-rectal space* is above the levator muscle, within the true pelvis, and only closed off from the free pelvic and abdominal cavities by the peritoneum.

An abscess of the ischio-rectal fossa shows itself with all the usual signs of an acute phlegmon, and can hardly be mistaken for anything else.

It may begin with chill and considerable constitutional disturbance; there will be severe pain, and the skin will be hard, red, and œdematous over a considerable part of the buttock. The pus, if allowed to take its own course, finds its way into the rectum as well as to the skin, and deep fistulæ are the result. It may, however, tend upward in the perineum, being less confined in that direction, and the urethra may be so pressed upon as to cause retention of urine.

There should be but one TREATMENT for this form of trouble, and that is an early and free use of *the knife*. It is a rule that an acute inflammation in this region will end in suppuration, and as soon as the brawny swelling appears it should be freely and deeply incised without waiting for pus. Pus will generally be present, however, before the surgeon is called. The treatment of such a case requires surgical skill. It is about as different from puncturing a superficial abscess and allowing the escape of pus through a small puncture as can well be conceived.

The patient should be etherized and placed in the lithotomy position. A long, fine, straight bistoury should be inserted in the centre of the cutaneous hardness, pushed forward, and occasionally turned in the wound, till pus issues by the side of the blade. It may be necessary to carry the point fully four inches upward, and to repeat the puncture more than once before pus is found. In withdrawing the knife an incision two or three inches long should be made through cellular tissue and skin. Into this the index finger should be passed, all sloughing tissue broken down, all pockets opened up, till it is certain that a free communication of all parts of the abscess with the external wound has been established, and that the incision is sufficiently free to prevent any further burrowing. The cavity should then be irrigated with bichloride solution 1 : 1000, and freely drained with iodoform gauze.

These abscesses should not be laid open into the rectum unless when first seen by the surgeon it is found that the pus has already approached so near the cavity of the gut that there is no probability of avoiding an internal fistulous opening. The treatment is that of an abscess anywhere, and not that of fistula, for if seen early there is no fistula, and if boldly and properly treated the formation of a fistula may be avoided, though not in all cases.

The *superior pelvi-rectal space* is bounded by the peritoneum above, the levator ani and its superior aponeurosis below, and the walls of the pelvis on the sides. It is filled up by lax pelvic connective tissue, which communicates in front and laterally with that which fills the iliac fossæ and the deeper regions of the abdomen through the intervention of the subperitoneal connective tissue of the pelvic walls. Behind it is continuous with the connective tissue of the meso-rectum and the concavity of the sacrum, and it communicates with the gluteal region through the sciatic notch. In women it is also continuous with the connective tissue of the broad ligaments.

It is easily understood from this why abscesses originating in this location may assume such vast proportions, burrowing laterally into the subperitoneal connective issue of the iliac fossæ, or almost anywhere else in the true pelvis; discharging into the bladder, vagina, or high up into the rectum; mounting above the bladder and pointing in the groin or loin; passing out of the pelvis into the thigh, and causing retention of urine, and even intestinal obstruction, from pressure.

In abscess of the pelvi-rectal space the SYMPTOMS are often obscured. There is more or less pain in the pelvis and lumbar regions, which is seldom intense. Fever may be entirely absent, is seldom continuous, and chills are only occasionally met with. The patient may soon sink into a typhoid condition, with high temperature and diarrhœa. I think I have more often been able to make an early diagnosis, before the discovery of tumor, by the presence of vesical and rectal tenesmus, with deep pelvic pain, than by any other signs.

The TREATMENT is, of course, that by *incision* and *drainage*, and the incision should be made as soon as pus can be located. It is true that these abscesses tend naturally to discharge themselves into the rectum, vagina, or bladder, but to leave them to their own course is attended by great risk. If the pus be approaching the perineum, the

FIG. 204.
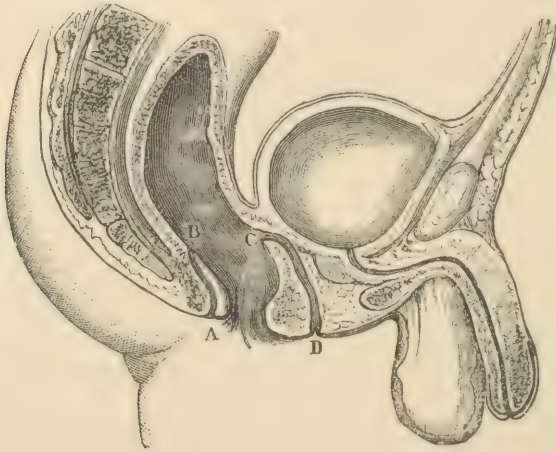
Pelvi-rectal fistulæ : *A, B*, subcutaneous ; *C, D*, submuscular (Potherat).

incision should be made there ; should it appear in the groin or thigh, free incision may be made there ; and should the tumor appear in the iliac fossa or above the bladder, laparotomy is indicated.

Except when treated boldly and surgically the PROGNOSIS in these cases is not good. In the beginning the patient runs the risk of blood-poisoning, peritonitis, and phlebitis, and should the abscess find safe exit there are still all the risks involved in prolonged suppurative disease. In the comparatively small number of cases in which spontaneous healing occurs the risk of extensive cicatricial contraction remains ; and this may cause either stricture of the rectum or sigmoid flexure on the one hand, or fecal incontinence on the other.

There is a form of periproctitis which is not to be confounded with this one. It is distinctly *septic* in origin, and is the chief cause of death after surgical operations in this region. It is analogous to puerperal septicæmia, and in its general symptoms follows closely the clinical history of pyæmia.

In those cases in which the inflammation shows a tendency to become circumscribed, life may be saved by proper surgical treatment, but where it is diffuse and invades the intermuscular planes of connective tissue, there is little hope.

I have seen infection start at the rectum, show itself as a brawny infiltration in the right iliac region, and extend up the right side to the axilla, without at any time becoming in the least circumscribed or allowing of surgical interference.

Small fistulæ of the subcutaneous variety, like the superficial abscesses from which they result, are generally easily curable by laying

open the track and scraping away with the handle of the scalpel the old granulation-tissue which lines it.

Fistulæ resulting from ischio-rectal abscesses differ greatly in their extent and gravity. In them the track is much larger, and often double or branching, and the external opening may be far away from the anus. The whole perineal region will sometimes be found brawny and indurated, and there may be a dozen or more points at which pus has burrowed to the surface.

The fistulæ resulting from abscesses in the superior pelvi-rectal space may be of any extent. The track may be very deep, and the probe passed into it may go directly away from instead of toward the rectum. Pus starting thus deep in the pelvis may find its exit in the groin, over the hip-joint, or even in the popliteal space.

Fig. 205.
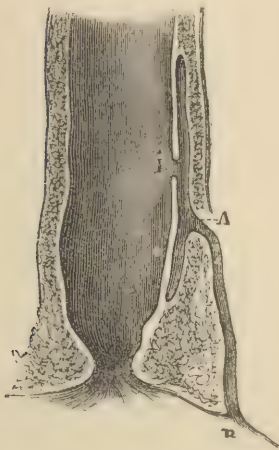
Complicated rectal fistula (Potherat).

Fig. 206.

Complicated rectal fistula, same as Fig. 205, but more complete (Potherat).

Tubercular fistulæ are generally easy to diagnosticate by their gross appearance without microscopic examination. In them the internal orifice is apt to be large, so that the finger may readily pass into it from the rectum; the skin over the track is undermined; the discharge is sanious and unhealthy; and the general condition of the patient helps the diagnosis. In *operating* upon such cases the entire track, after being laid open, should be thoroughly *destroyed*, either with the sharp scoop or the cautery. There seems little doubt that such a fistula may be the starting-point of general tuberculosis, and that a radical operation done early may prevent general infection.

A fistula may heal spontaneously or after a very slight excitement to reparative action, such as the mere passage of a probe in an examination. Such cases are, however, exceedingly rare. In certain cases a cure may also be effected by stimulating the track by injections of iodine, or by local applications of various caustics, or by the introduction of tents, etc. Treatment by any of these methods requires time and patience, and the result cannot be looked upon as at all certain.

When it has been decided to lay a fistula open into the gut, there is

but one method to be recommended, and that is the knife. The elastic ligature or écraseur need not be considered except in cases where the incision is so deep that concealed hemorrhage is to be guarded against ; and the silk ligature is unsurgical.

Where the fistulous tracks exist in great numbers, *two or three operations* at intervals may be advisable, rather than an attempt to cure at one sitting. It is easily possible in such cases to do an amount of cutting that shall endanger the recuperative power of the patient. Many of the tracks will be found to run away from the gut and be merely subcutaneous, and it may be possible to divide the different openings into two or three groups, each group having its own independent deep communication with the bowel.

Although to effect a cure in some cases it may be necessary to divide the sphincters in two or three different places, and in such a greater or less degree of incontinence is to be expected, a double division of the sphincters is always to be carefully avoided if possible. It is wonderful how many different tracks may be laid open and made to drain freely into a single median incision behind, if care and study be devoted to this point. Especially does this apply to the various forms of horseshoe abscess, in which pus has burrowed around the gut in a semicircle either in front or behind, and in which there are often two external and two internal openings.

In all of these operations it is well to bear in mind that a large percentage of all cases are failures, even in hospital practice. This arises from the popular conception that a fistula is a straight track leading from an external opening in the skin to an internal opening in the bowel, and that the operation consists in first passing a director along this track and then dividing it. On the contrary, most fistulæ are *branching, complicated tracks*, which need to be dissected up and laid open with great care. The director needs only to be introduced a short distance at a time to do this, and many cases are better operated upon without a director.

The *after-treatment* should be as simple as possible. After the first dressing of gauze has been removed, it is generally only necessary to pass a finger into the deep parts of the cut twice a week to see that it is open well down to the bottom and that no pockets have formed.

ULCERATION AND STRICTURE.

The simplest form of ulcer met with at the anus is what is universally known as a **fissure**. Although almost invariably due to the traumatism of a large and hard fecal movement, it probably may in a few cases be due to an ulceration of one of the sinuses of Morgagni and a thickening and tearing downward of the little valve of mucous membrane which forms the pouch.

This is the explanation given by Ball of the frequent coexistence of fissure with an inflamed tag of skin at its lower edge, known as a *"sentinel pile."*

Next in frequency to the *fissure* comes the large class of **ulcers due to traumatism**, and the traumatism is generally surgical in character. Wounds of the rectum are proverbially hard to heal under the best treatment, and when neglected or badly treated change rapidly from healthy wounds to unhealthy ulcerations.

In this way patients who have had slight operations for hemorrhoids or fistulæ, and have passed out of observation with the wounds healthy and cicatrizing, will

return years later with extensive and incurable ulceration and stricture. So frequent is this that in every case of doubtful etiology the history in this regard should be carefully inquired into.

Allied to these cases are those in which the traumatism is due to *chronic constipation* and the pressure of scybalæ upon the mucous membrane. Death has more than once been caused by perforation of the sigmoid flexure due to the pressure of a scybalous mass, and *severe ulceration* of the rectal pouch may be due to the same cause.

Traumatism due to *parturition* is supposed to account for the much greater frequency of ulceration and stricture in women than in men. Though the possibility of such traumatism cannot be denied, the greater frequency of ulceration and stricture in women may be doubted—at least if my own experience is of any value. For fifteen years I have kept an accurate table of all of these cases seen in private and hospital practice, and in the total (amounting to several hundreds) the male and female patients are about equal.

There is another causative influence which is also peculiar to women, which I have seen several times. It is the pressure upon the rectum of a *prolapsed and retroverted uterus.*

Tubercular ulceration may occur anywhere in the length of the alimentary canal, and is not very infrequent in the skin at the margin of the anus. It is characterized by its *pale-red surface,* covered with a small quantity of serum, but devoid of healthy pus, giving it a varnished appearance ; by the *absence of surrounding inflammation* and the granulations which exist in a healthy sore ; by its *tendency to spread in depth* rather than on the surface ; by the absence of pain ; by the irregular outline ending abruptly in healthy skin ; and, above all, by its *chronicity* and the utter failure of all ordinary remedies to affect its course. The diagnosis may be confirmed by the microscope. Tuberculosis of the rectum or anus may be a primary affection, but is generally associated with deposit elsewhere.

FIG. 207.

Diagram of the nervous connections between an anal fissure and the spinal cord : *C D E,* centripetal and centrifugal nerves (Hilton).

Tubercular ulceration of the rectum is not generally a cause of stricture, there being too much destruction of the parts and too little cicatrization and inflammatory thickening to cause occlusion of the canal. It is, however, a not infrequent cause of fistula, the deposit and ulceration commencing in the mucous membrane and perforating the wall of the gut, causing an abscess in the surrounding cellular tissue which ends by again perforating the skin. Such a fistula is characterized by its internal orifice, which is so large that the finger used for rectal examination may pass directly into it without force.

The ulcers resulting from dysentery vary much in extent and location, and, although their favorite site is at the rectum and sigmoid flexure, they may occur anywhere in the large intestine. I know of no way in which old dysenteric ulcers can be positively distinguished from chronic ulceration of other varieties except by the history of the disease, but I

am convinced that it is by no means an uncommon condition even in our Northern cities.

It was for many years doubted whether dysenteric ulceration ever resulted in stricture of the rectum, but careful observation has collected a sufficient number of cases to set the question for ever at rest.

There is still one other form of chronic ulceration of the anus, vulva, rectum, and vagina which has been described under various names, and which until within the past few years was supposed to be a distinct affection. Perhaps the name by which it was best known was **esthiomene**. It has been attributed to syphilis and scrofula ; has been considered both as lupus and elephantiasis, and as an affection *sui generis* of unknown etiology. Nobody, I think, before R. W. Taylor grasped the fact, which was evident to him from his large experience in the venereal wards of Charity Hospital in New York, recognized that the greater number of these chronic, deforming vulvar and anal affections "are due to simple hyperplasia of the tissues induced by irritating causes, inflammation and traumatism." In other words, he fails to find any such disease as *esthiomène*, but he does find that any lesion around these parts, especially in old syphilitic subjects, may take on a hypertrophic action. A chronic chancroid may do the same, and no venereal lesion is absolutely essential.

The condition is recognized by the *great extent of the ulceration*, often destroying the rectum and vagina entirely ; by its *slow course*, often lasting many years without affecting the general health ; and by the great *hypertrophy* of the affected parts. *It is most apt to be mistaken for cancer, phagedenic chancroid,* or *elephantiasis.*

The TREATMENT should consist in destructive cauterization. In many of these cases antisyphilitic treatment will do good, but by no means in all.

And yet the fact that the disease is sometimes a peculiar manifestation of syphilis is proven to my own mind by a case I once saw in which the disease was congenital, was associated with other signs of inherited syphilis, and was greatly benefited and nearly cured by mercury and potassium iodide.

There are also several varieties of **venereal ulceration** met with in the rectum and at the anus.

Gonorrhœa of the rectum may be so severe as to cause distinct ulceration within the pouch, and the irritating discharge from the anus may cause erosions and fissures, or previously exising fissures may become inoculated and spread.

Chancroids of the anus may be caused by direct contagion or by auto-inoculation, and, though they may be caused by unnatural vice, their mere presence is no proof of the habit. They are much more common in females than males, because of the facility of auto-inoculation and the frequency of accidental contact of the male organ.

Although chancroid of the anus tends to spontaneous cure, and is usually a very superficial ulceration, it occasionally happens that the disease is attended by a certain amount of phagedena, and in such cases may extend within the rectal pouch, cause considerable destruction of tissue, and end in stricture. That this is the usual or even a common cause of the so-called "syphilitic" stricture of the rectum I do not believe.

True chancre at the anus is not very uncommon, though it may pass

unnoticed. Its presence in the male is proof positive of unnatural vice, as the lesion is not auto-inoculable.

True chancre *within the rectal pouch* has seldom been observed, though occasional cases are on record—one recently, which seems conclusive, by Hartley.

Mucous patches are very frequent around the anus, and assume two distinct types, the ulcerative and the vegetating. It is to the latter alone that the so commonly improperly used term "condyloma" should be confined.

Of the existence of **secondary syphilitic ulceration** within the rectal pouch there is no more doubt than of its existence in the fauces and trachea. There is also no doubt in my own mind that this form of ulceration may occasionally result in *true syphilitic stricture ;* but that it often does so, or that the so-called syphilitic stricture is really syphilitic at all, I do not believe.

The time for jumping to the conclusion that because a patient has a stricture of the rectum which is not cancerous, he or she must have had syphilis, has gone by. There is, I think, no rarer lesion of the rectum than a syphilitic stricture. Syphilis undoubtedly causes stricture of the larynx and trachea, perhaps also of the œsophagus, but these constrictions are caused by the cicatrization of lesions which were primarily ulcerative. They are irregular cicatrices and salient bands which deform and occlude the organ, and they in no way resemble the masses of inflammatory deposit in the rectum which have been for so many years improperly regarded as a proof of syphilis.

The argument against the syphilitic character of these old and extensive strictures is made still stronger by the fact that many of the sufferers have never had syphilis in any recognizable form, and by the additional fact that specific treatment is absolutely powerless to cause their resolution, though it has such a wonderful effect in other tertiary manifestations. To explain this failure, it is customary to say that the period of infection is too remote from the trial of the drugs, that sclerosis of the rectum has already been established, and that specific treatment is powerless against sclerosis. But it is evident that there must be some period in the development of this disease, if it be syphilitic, at which specific treatment would have an effect, and clinically that period has never been found. Instead, therefore, of classing these old strictures as ano-rectal syphiloma, they should be described as examples of simple proctitis in which the secondary results, as hypertrophy, proliferation, and contraction, are present to an extent sufficient to cause occlusion of the canal.

In thus enumerating the different varieties of ulceration of the rectum we have also enumerated most of the *causes of stricture*, which in the great majority of cases is a simple result of ulceration. *Any simple ulceration of the rectum*, if left to its own course, and more especially if badly or improperly treated, *may result in a stricture* from hyperæmic overgrowth and contraction, and nearly all strictures not cancerous are of this nature. The only other varieties known are the congenital, the spasmodic, and those due to extensive traumatism or pressure from outside the canal.

Congenital stricture of the rectal pouch is not very uncommon, and may not be discovered till the patient reaches adult life. For years the disease will cause little trouble, and the patient may only be aware of the fact that the passages are always very small in calibre; but as age advances the tissue composing the constriction becomes firmer, the difficulty in defecation increases, and finally a digital examination reveals the nature of the affection.

Spasmodic stricture is very rare, and only, I think, associated with some other disease, as ulceration of the rectum. It has, however, been reported by good observers. By "spasmodic stricture" I mean an occlusion due purely to muscular contraction sufficient to prevent the passage of the finger without ether, and disappearing completely under an anæsthetic.

Stricture due to the **pressure of growths** in the pelvis or the pelvic exudations or abscesses need not be considered at any length in this connection.

Cancerous stricture is more common in the rectum than any other part of the alimentary canal. As its treatment is now the same as that of non-malignant contraction, no especial space will be devoted to its pathology or symptomatology.

The TREATMENT **of ulceration of the rectum** without stricture has come to be almost entirely *operative* when the ulceration has reached a point which has involved any great loss of tissue. Only the slighter cases are curable by local applications. Superficial destruction of the mucous membrane, even over a considerable area, may be curable by proper local treatment, and a deep loss of tissue confined to a comparatively small area may also be induced to cicatrize without very much subsequent contraction; but, unfortunately, the disease is an insidious one, and rapidly passes the curable stage. The choice often rests between *colostomy* and *extirpation of the rectum*.

The treatment of stricture, both *cancerous* and *benign*, has also come at the present day to be entirely *operative*, and to consist either in *colostomy* or *extirpation*. In only a few of the simplest forms of non-malignant disease is the operation of division with subsequent dilatation of any permanent value, as the dilatation can seldom be maintained at a point which will accomplish anything, on account of the irritation it produces.

In deciding between colostomy and extirpation in any particular case, whether malignant or benign, the present tendency is to do an *extirpation when we can*, and a *colostomy when we must*.

Certainly this is the unquestioned rule in malignant disease; and if the mortality of extirpation could be still further decreased and the parts left in a little better condition functionally by further improvements in technique, it would also be the unquestioned rule in non-malignant cases.

No argument is necessary at the present day to prove the advantages of colostomy in these cases. The only question now is whether extirpation in non-malignant cases offers sufficient advantages over colostomy to compensate for its great additional risk.

COLOSTOMY.

In doing colostomy less preparation of the patient is necessary. In cases of prolonged obstruction delay is dangerous and purgation out of the question, and in others there is no occasion for emptying the alimentary canal. In fact, the presence of scybalous masses in the sigmoid flexure is one of the best guides to the part of the bowel to be opened.

The parts should be scrubbed as in all laparotomies, and the incision should be about two inches long, crossing an imaginary line from the anterior·superior spine to the umbilicus at a point one and a half

inches from the spinous process. When the abdomen has been opened by this incision the sigmoid flexure, if in its normal position, will be the first loop of intestine presenting. Before searching for it, however, a silkworm suture with shot and shield on one end should be passed through all the layers of the abdominal wall from without inward at a point about half an inch from the inner lip of the wound, and the needle, still threaded, brought out through the incision and laid to one side. Search may then be made for the sigmoid. If it happen that the small gut present, the best place to search is between the incision and the anterior superior spine, close to the wall of the abdomen. Hook the finger into the wound and draw it along the abdominal wall from the side of the pelvis outward toward the incision, and the sigmoid will often be caught by it.

When a proper piece of gut has been drawn through the wound, the needle is again taken up and passed through the mesentery of the loop close to the gut, and then through the whole thickness of the abdominal wall from within outward at a point half an inch from the incision on the side toward the spinous process. When this has been drawn taut and secured by a second shot and shield, the loop of gut will be securely held outside of the abdomen by a suture passing under it through its mesentery and through the whole abdominal wall on each side.

The gut is next to be secured more accurately in its place by six or eight silk sutures passed as follows : The needle passes first through the skin at the margin of the incision ; next through the cut edge of the parietal peritoneum ; next through the muscular layer of the gut, but not into its calibre. When such a stitch is tied, it is evident that the gut will be attached to the skin margin of the incision, and that the peritoneal cavity will be closed by the union of the parietal and visceral layers at that point.

Enough of these sutures should be used to completely shut off the peritoneal cavity. This part of the operation will be greatly facilitated if, when the peritoneum is first incised, its cut edges be seized and held at half a dozen different points with forceps, and these be allowed to remain till replaced by the sutures. In this way the stitches can be replaced without wasting time in searching for the edge of the peritoneum.

Before any suturing is done except the first suspensory suture of silkworm gut, the loop of intestine should be drawn well out of the wound, and a longitudinal band selected through which the sutures can be passed for greater strength. One of these is always available, and not infrequently use may be made of one on each side of the bowel.

When the suturing is finished a loop of gut at least two inches and a half in length should be secured in the incision with one-half its calibre at least outside of the body, and the peritoneal cavity completely shut off around it. The gut may *now be opened* without waiting for adhesions. This is done by first snipping into its cavity with a pair of scissors, introducing a finger for a guide, and paring away the exposed wall down to within a quarter of an inch of the line of sutures. One or two small vessels may have to be tied.

The appearance of the bowel after it is opened should be like that of a double-barrelled gun with a sharp ridge between the two barrels, where the gut is sharply bent over the silkworm suture.

The *accepted practice for the past few years* has been to allow at least forty-eight hours to elapse between stitching the gut to the abdominal wall and opening it. Besides entailing a second slight operation, which is often attended by considerable dread and nervous shock, the practice is troublesome from the fact that the operator if at a distance from home is compelled either to wait two days or return. *Five or six hours is amply sufficient* to secure the shutting off of the general peritoneal cavity by exudate, but the writer has found even this delay unnecessary where proper care is given to the suturing, and now completes the operation at one sitting.

The old practice of passing a couple of sutures directly through the calibre of the bowel and out again on the other side, then opening the gut, drawing them out from its interior, and cutting them so as to make two sutures on each side, is fatally defective in the fact that such a suture cannot by any possibility be aseptic at its point of exit, and hence stitch-abscess may be expected.

Nothing need be said of the old operation of *lumbar colostomy*, except that it is much more difficult to perform, much less satisfactory in preventing the passage of fæces into the diseased part of the bowel, and can hardly be necessary under any circumstances. Any part of the large intestine except the caput coli can be brought to the incision in the left groin and fastened there. At least the writer has found by experience that both the ascending and transverse colon may be thus operated upon through this incision.

One of the most troublesome complications liable to be met with is a sigmoid flexure practically without mesentery, and firmly bound down to the loin and brim of the pelvis, so that it cannot be brought out of the incision. In a marked case of this sort it is sometimes better to abandon the sigmoid and seek a more movable portion higher up.

Hernia of the small intestine through the incision, even after the large gut has been stitched into it, *is possible*, and if not immediately discovered and replaced may be fatal.

It is less liable to occur with the operation done as described than with the old plan of waiting forty-eight hours, and is much less liable to occur when the general peritoneal cavity has been closed by eight or ten sutures, such as described, than when the operator has become carelessly confident and has about decided that so many sutures are unnecessary. The fact of having twice met with this accident has always prevented the writer from adopting the very simple plan of passing a glass rod under the gut to hold it in the incision, and dispensing with the sutures, as has been done in England.

No surprise need be felt if the first movement from the artificial anus is delayed for several days, as the bowel has often lost its tonicity from chronic obstruction before the operation.

After healing is complete the patient should always wear a broad *abdominal belt* and a *pad* of cotton over the opening, to prevent prolapsus. Trusses are seldom well borne. Care must also be exercised to prevent excoriation of the exposed mucosa.

In non-malignant disease the prospect of cure and subsequent closure of the artificial anus should always be held out to the patient. It will give great comfort, and it may be done in any one of several ways, but is a more difficult operation than the original one.

Finally, these patients will soon find that a person may be very comfortable with an artificial anus in the left groin; and the higher the patient's social condition, and the more care he is able to give to his person, the more comfortable will he be. With such the annoyance of the artificial anus is apt to sink into insignificance in comparison with the result hoped for from its formation. The laboring-

man is the worst sufferer, because he is apt to get a hernia at the site of the wound, and because he does not or cannot care for himself as he should.

EXTIRPATION OF RECTUM.

At least four days should be allowed in which to prepare a patient for extirpation of the rectum. On the evening of the first day, three compound cathartic pills should be given, and these should be repeated on the evening of the second. The day before the operation the diet should be exclusively milk and beef tea, preferably the latter, and on the evening before, a dose of bismuth and morphia should be given. This should be repeated on the morning of the operation. The idea of this preparatory treatment is plainly to have the alimentary canal as empty as possible before operating, and to postpone as long as possible the first movement of the bowels after the operation.

No preparation of the site of the operation is made before the ether is given, but then great care should be devoted to this point. With the patient in the lithotomy position the perineum is first shaved and the rectum thoroughly cleansed. This is done through a speculum with frequent irrigations of bichloride solution (1 : 500), and by carefully wiping out the canal as high up as possible with pledgets of iodoform gauze on long forceps.

Very often it will be a great help to the operator to introduce his finger into the canal during the operation, and in any case it will be necessary to cut the bowel across above the disease. In doing either of these things the whole wound is apt to become infected, and the object of the preliminary disinfection is to reduce this risk as much as possible. The disinfection may not be chemically or theoretically perfect, but exactly in proportion to its thoroughness will the mortality of the operation be decreased.

A small tampon of iodoform gauze may be left in the rectum, but too great a mass distends the canal, obscures the limits of the disease while operating, and distorts the normal anatomy.

The patient is next turned on the face or practically so, and the whole site of operation scrubbed and disinfected. Soap and brush, if well applied, with a final washing of bichloride, and after that of ether, will be found efficient.

The *incision* should be begun at a point two inches to the left of the middle of the sacrum, slanting it toward the median line, and on reaching it extended along the fold between the buttocks to the anus. This incision should be made to reach bone at once, and flaps should be turned to each side by a few strokes of the knife. The right flap should freely expose the lower right half of the sacrum, that on the left the ligaments connecting the sacrum with the rest of the pelvis, and these should be divided. A periosteal elevator is then passed under the sacrum from left to right (the operator stands on the left) at the level of the incision to be made across that bone, and is worked down under sacrum and coccyx till the anterior surface of the bone is freed from soft tissues. In this way very troublesome hemorrhage from the sacra media and its veins may be avoided. When the periosteal elevator has been removed, one blade of a long, strong, straight bone-forceps is passed under the sacrum, and the bone is divided transversely, the lower fragment, with the coccyx, being completely removed. Usually this triangular piece should consist of the last two sacral vertebræ and the coccyx.

All of this preliminary work should be finished in less time than it takes to describe it, and only slight bleeding will be caused by it. This

may generally be disregarded, and will cease spontaneously unless some of the veins of the sacral plexus have been injured. Should there be a persistent loss of blood from just under the stump of the sacrum, it must be controlled either by forceps or pressure with the finger, as it is often exceedingly difficult to get a ligature under this point. A ligature on a needle will sometimes do what cannot be done in any other way, but forceps are generally sufficient. Particular attention is called to this minor point, as it is often a troublesome one.

The pelvis being now freely opened, the operation may proceed. First, the gut should be isolated on each side by the finger; no cutting is necessary. In part the gut will roll out of its bed with great ease, but it will not come down, and the finger cannot be passed completely under it, for this is its largest part, and it is still firmly held by the peritoneum and connective tissue between it and the sacrum. The key to the rest of the operation is the peritoneum, which should be found and opened before any attempt is made to drag down the gut. This may take time, and several small incisions may be made into the cellular tissue covering the peritoneum before its cavity is opened; but when the finger is once fairly within the free peritoneal cavity the greatest difficulties in the operation have been overcome. I usually make the opening into the peritoneum on the right side of the gut, introduce the finger, hook it under the gut, and force it out through the peritoneum and cellular tissue again till its end appears free on the left side of the rectum. In this way the fold of Douglas is torn open and away from the bowel, and the rectum is prevented from coming down only by the mesorectum and cellular tissue between it and the hollow of the sacrum. While gentle tension is made upon the gut with the finger hooked under it, this last obstacle to its free descent may be cut away.

The mesorectum must be cut as little as possible. If it be stripped off from the gut to too great an extent, the bowel will slough for lack of nourishment. It is generally easy to feel, before the gut is opened, the extent of the disease to be removed, and the rectum should be cut across above it—if for cancer, at least an inch above. No bleeding need be feared from cutting across the gut. Unfortunately, it will often be found only too feebly supplied with vessels after the mesorectum has been cut sufficiently to allow the stump to come down into the wound. Something much more to be feared is soiling the wound with the contents of the bowel. This may best be avoided by dividing it between two ligatures made of gauze, or between two intestinal clamps, after the wound has been carefully protected by packing with gauze to be subsequently thrown away. The upper end after division should be carefully wiped with iodoform gauze, and given to an assistant; the lower end should be seized firmly by the operator, stripped quickly from its anterior attachments by pulling it downward and outward, and either removed as a whole or amputated below the disease. If it be removed down to the anus, the levator will need to be cut on each side.

The operator now has the whole pelvic cavity at his command. In women, tubes, ovaries, and uterus can be plainly seen and easily examined. Several times I have removed tubes and ovaries at this stage of the operation where their removal was imperative, but I prefer not to do it. The shock of an extirpation may be more than a patient can bear, without any additional traumatism.

The next point to be decided is what to do with the upper end of the gut—whether to bring it down to the skin and make an anus in the natural place in the perineum, to suture it to any portion of the rectum which may have been preserved near the anus, or to bring it out in the middle of the wound and suture it to the skin just below the stump of the sacrum.

This is often a very difficult point to decide, and one upon which not only the subsequent comfort of the patient, but also his life, may depend. If it is determined to bring the stump down to the skin of the perineum, a trial must be made to see if it is sufficiently long and movable, and if not, the mesentery and cellular tissue must be divided a little more freely.

After this has been decided the toilette of the peritoneum should be made with hot water or saline solution and sponges, exactly as in a laparotomy. The end of the gut should then be stitched to the point decided upon, all parts of the wound should be closed by deep and superficial sutures as carefully as possible, and a tent of gauze should be left in the deep part for drainage. Almost always the suturing will stop all bleeding, and no time need be devoted to special suture of the rent in the peritoneum.

When the anal portion of the rectum has been removed with the rest, there is apt to be a free and continuous oozing of blood from the bed in which the lower rectum lay. There is no spurting vessel and nothing to tie, and yet there may be lost a good deal of blood. This is best controlled by deep sutures, drawing the sides of the cavity together.

It is evident that this is an operation of precision, very different from the more or less blind plunge into the perineal region formerly in vogue. It can be completed by a rapid and experienced operator in about forty-five minutes, while one unfamiliar with it may spend three or four hours in controlling hemorrhage which, if left to itself, would cease without ligatures.

Many COMPLICATIONS may arise during its performance.

One of the most awkward I ever personally encountered was to find a rectum absolutely without mesentery and bound immovably to the hollow of the sacrum by connective tissue. All attempts to bring it down resulted simply in tearing up one of the longitudinal bands, and at the end I held in my hand simply six or eight inches of stripped and injured gut, without any source of nutrition. During a great part of the operation a loop of large bowel, the upper part of the sigmoid flexure, had been hanging loosely in the field and occasionally coming in the way; and it finally occurred to me that this would answer my purpose as well as anything else. It was therefore stitched to the edges of the incision and opened much as in an inguinal colostomy. The end of the gut beyond the artificial opening was arranged so that none of its contents could escape into the wound, and the patient recovered with as useful an anus as is customary.

Regarding the final disposition of the end of the gut where it has been cut off above the disease, there are many things to be considered. The safest and simplest operation is the old one of stitching it to the skin just below the stump of the sacrum. This does away with much of the danger of sloughing, and hence reduces the mortality, but leaves an anus that is not as satisfactory to either patient or surgeon as one in its natural place.

In cases of cancer, where all questions of future comfort are as nothing compared to the great one of saving life by removal of the disease, it may be perfectly

proper to disregard the minor point of future functional control, and aim simply to save life with the least possible risk. But in cases of non-malignant ulceration and stricture demanding excision the subsequent condition of the patient will be found a matter of more consequence. The surgeon may know he has as surely saved the life of such a patient as though he had removed a cancer; but the patient may not appreciate it, and may be tempted to compare his last state with his first, even though he may have gained many pounds in weight and be cured of his disease.

Doubtless the theoretically perfect operation is the one that removes the disease and leaves the patient with as good functional control as he had before; and this may frequently be accomplished both in cases where the disease has been confined to the lower end of the gut, and where after amputation of two or three inches the stump can be stitched to the skin of the perineum; and in cases of disease quite high up which allows room after resection for careful apposition of the two ends. But this last operation is attended by many failures, and more risk than either bringing the stump down to the skin of the perineum or turning it sharply backward just below the stump of the sacrum. The upper segment is poorly supplied with nourishment, and the lower has no peritoneal investment. The most careful suturing will fail of its object, and the Murphy button will slough out. In either case the whole wound becomes foul with fæces, and the mortality is greatly increased.

This risk is unquestionably greatly reduced by *preliminary colostomy*. In deciding upon the final disposition of the stump of the bowel, the operator will be chiefly guided by its vitalization and the extent to which the mesentery has been injured in loosening the rectum. In some cases it will evidently be so impoverished that it can only be brought out in the sacral region.

Absolute sphincteric control should never be promised after extirpation. Few patients have it before the operation, and fewer still will have it after. The most that can be hoped for is that the patient will be as comfortable after as before in this regard, which means that he will know when an evacuation is impending and have time to attend to himself.

When the stump has been brought down to the perineum and a fecal fistula still remains at some point in the line of incision, there is always a chance for a successful operation to close the latter. The gut itself should first be dissected loose and closed by a Lembert suture, and then the skin should be closed over the opening. Attempts at closure of such fistulæ by plastic operations on the skin alone, leaving the opening in the gut to care for itself, have generally not succeeded.

Such in a general way is the operation for *extirpation of the rectum*, either cancerous or strictured and ulcerated, and the secret of its mortality will be found to lie much more in perfect antisepsis than in the amount of shock.

My own first statistics showed the full death-rate of 30 per cent. This has been gradually reduced until during the past winter I had only 1 death in 13 cases, the last 12 being uninterruptedly successful. That the improvement has been due solely to increased care and better technique I have no doubt. A successful case will now leave the hospital in about three weeks, and I have had patients sitting up in bed at the end of one.

CHAPTER XI.

GENITO-URINARY SURGERY.

By William T. Belfield, M. D.

Malformations.

Prepuce.—The foreskin exhibits three common abnormalities—undue length, tightness, and adhesion to the glans penis. These three features are commonly combined in *congenital phimosis*, or inability to retract the prepuce behind the glans. This condition—and the accumulation of smegma under the foreskin which commonly accompanies it—is responsible for many morbid states : it causes in childhood local irritation and soreness, straining and pain in urination, and a tendency toward hernia (in every case of acquired hernia in children the prepuce should be examined, and, if phimosis exist, removed as a part of the treatment of the hernia). In certain cases, disorders of the nervous system, such as convulsions, epilepsy, chorea, and paresis, have ceased after the removal of a tight prepuce. In later life phimosis favors balanitis, unnatural excitability of the sexual organs, as shown by frequent emissions and nervous phenomena, and it greatly increases the danger of venereal infection.

For these reasons *phimosis* should be promptly relieved by *circumcision* whenever brought to the physician's attention.

Penis.—*Absence of the penis*, except as the result of disease or injury, is very rare, and is always associated with arrest of development in adjacent organs. Apparent absence of the penis at birth is less rare, and is due to a *misplacement* of the organ, which may be detected as a firm cylinder beneath the skin of the scrotum, perineum, or suprapubic space. It can be liberated by suitable incision and restored to its normal position ; a proper covering can be secured by plastic operation.

Rudimentary and *multiple penis* have been occasionally observed.

Absence of the urethra, which is replaced by a fibrous cord, occasionally occurs. This usually results in the death of the foetus before the completion of intra-uterine life, because the distended bladder presses upon the umbilical arteries and thus impairs the nutrition of the foetus. Yet in a few instances such a child has been born alive ; in some of these it is found that the urachus has reopened and serves as a urethra ; in others the recto-vesical partition is imperfect ; while in a third class the bladder is found enormously distended at birth and needing immediate surgical treatment. Occasionally such a bladder has formed an obstacle to delivery until punctured. For practical purposes this condition is identical with the following :

Congenital Occlusion (Atresia) of the Urethra.—This results from a fusion of the urethral walls over a small area, and is most common in the vicinity of the meatus and often associated with *hypospadias*. Attention is attracted by the child's failure to urinate and by the distention of the bladder. Examination may show an occluded meatus, which should be incised; a small button probe is gently passed backward to the bulb, unless the urine flows before that point is reached; if further separation is needed, the probe is replaced by a small elastic catheter, with which a gentle effort is made to overcome the obstruction.

Sometimes these efforts have failed to reopen the urethra: the surgeon must then tap the pervious portion of the urinary channel, either the bladder itself or the distended portion of the urethra; from this point of vantage attempts may be made to pass instruments from behind forward along the urethra. It should be remembered that in such a child there probably exists distention of the ureter, hydronephrosis, and pressure atrophy of the kidney, from which causes death may ensue even when the urethral canal has been re-established.

Congenital urethral pouches are rare distentions of the floor of the penile urethra, holding from an ounce to a pint of urine; though apparently resulting from an impediment to the escape of urine, such obstacle has not usually been detected in the cases examined. It is possible that the impediment was a temporary barrier (occlusion) between the penile and glandular urethra, which has been broken through after the formation of the pouch.

TREATMENT consists in excising the redundant skin and mucous membrane, leaving just enough to form a urethra of natural calibre by apposition ef the cut edges.

Hypospadias and **epispadias** are terms designating congenital defects in the urethral walls, as a result of which the urine escapes from the penis at some point posterior to the normal exit, the meatus.

These defects are probably due to the conditions already described— congenital occlusion and pouching of the urethra, followed by rupture of its walls prior to birth, and cicatricial contraction of the ruptured edges, often with adhesions to the scrotum, which sometimes cause a turning or "torsion" of the penis on its axis.

The commonest locality for congenital occlusion is at the junction of the glans penis with the spongy urethra, for these two portions are separately developed, the penile urethra growing forward from the pubic bone, the glandular urethra dipping backward from the tip of the glans. These two blind canals normally meet at the posterior surface of the glans, and coalesce through the absorption of the intervening tissue. If, however, this coalescence into a complete canal be prevented by the persistence of a barrier of intervening tissue, various abnormal sequences may occur: (1) simple congenital occlusion; (2) pouching of the penile urethra behind the barrier; and (3) rupture of the distended urethra, resulting in hypospadias if the rupture be, as it usually is, on the under surface; and in epispadias if the rupture occur on the upper surface of the urethra.

Hypospadias is a common deformity occurring in one out of every four or five hundred males. It is designated as glandular, penile, or perineal according as the abnormal urethral opening is in the glans, body of the penis, or perineum: the commonest locality is just behind the glans. In any case the urethra anterior to the opening is represented by a groove on the under surface of the penis, except that

occasionally the part contained in the glans is perfect. There is usually a marked deflection of the glans from the normal line, and often a deformity of the prepuce; the entire penis is apt to be of small size and have a downward curve; adhesions to the scrotum are not rare.

Fig. 208.
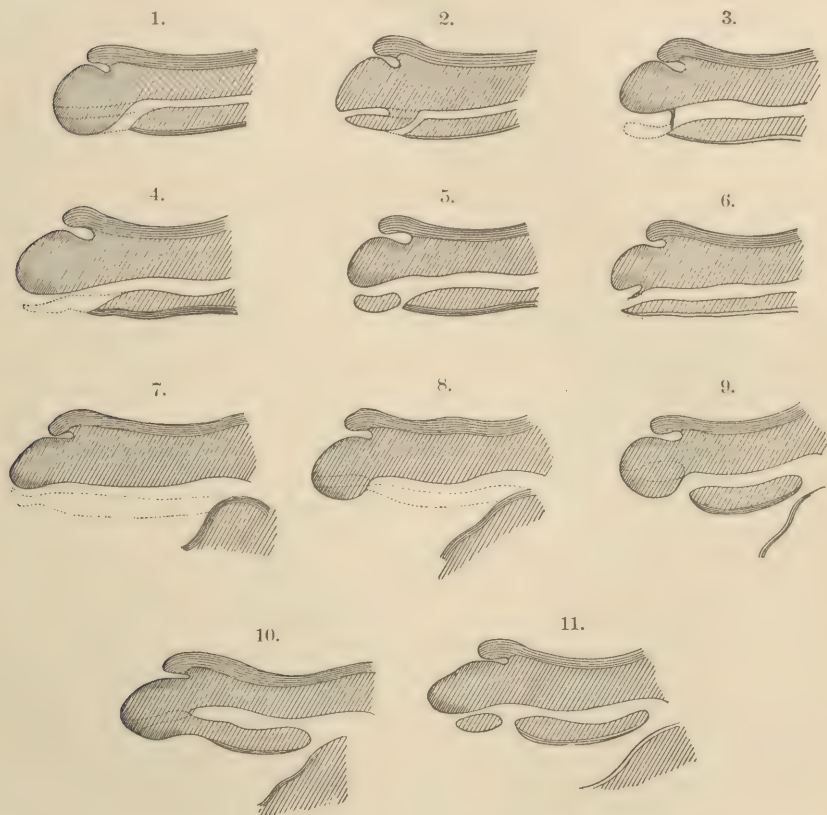
Diagrammatic sections showing different varieties of hypospadias (Kauffmann): 1, hypospadias with imperforate glans; 2, hypospadias with blind canal in glans; 3, with barrier placed between penile urethra and balanitic groove; 4, typical case of hypospadias; 5, hypospadias with normal meatus; 6, penile urethra opening below glans; 7, absence of the whole inferior part of the penile urethra; 8, hypospadias with absence of urethra through glans; 9, case of D'Arnaud; 10, case of Lacroix; 11, case of Lippert with normal meatus.

If the abnormal urethral opening lies behind the scrotum, this sac is split into two, which may be widely separated. In this case the appearance of the external genitals—especially when the testicles are undescended—simulates more or less perfectly that of the external female organs; hence the individual is often considered an hermaphrodite. Closer examination, however, enables one to recognize in the adult the distorted male organs, and a finger in the rectum detects the prostate, though this may be smaller and thinner than usual. Nearly all the professed hermaphrodites, including the individuals who exhibit themselves at medical schools under this name, are merely males displaying an extreme degree of perineal hypospadias.

In infancy, however, especially if the testicles have not descended, resemblance to the external organs of the female is so great that these subjects of perineal hypospadias are often brought up as girls; their true sex remains unsuspected until puberty, when the development of masculine characteristics of figure, voice, and beard lead to a discovery of their masculinity.

Hypospadias causes a disturbance in urination proportionate to the degree of deformity: in the glandular form this is slight, while in the perineal variety the individual cannot project the urine, and is therefore compelled to assume the sitting posture in urination.

Epispadias, caused by the rupture of the upper surface of the fœtal urethra, is far less common than hypospadias. A few instances of epispadias limited to the glans penis or in the anterior portion of the penile urethra, have been recorded; usually, however, the defect of the upper wall is associated with a similar defect in the bladder and abdominal wall and an imperfect union of the symphysis—the condition known as exstrophy of the bladder.

Epispadias involving the deep urethra usually occasions great distress to the patient because of the inability to retain the urine, for the deep urethra is normally the chief sphincter of the bladder.

Bladder.—*Absence of the bladder* has been detected post-mortem in a few instances, but has no clinical importance.

Division of the bladder by a more or less complete septum is likewise a rare condition, which might, however, puzzle the surgeon in case of calculus-formation in one of the cavities.

Hernia of the bladder is a by no means infrequent condition, the possibility of which should not be forgotten in considering tumors at the various pelvic outlets, particularly the inguinal canal.

Hernia of the bladder into the inguinal canal or even the scrotum of the male, with or without intestine, omentum, or an undescended testicle, has repeatedly surprised surgeons when operating for a supposed intestinal hernia. Skilful operators have opened the bladder in this locality, discovering their mistake only through the escape of urine. The possibility of vesical hernia as the cause of an inguinal swelling is suggested if the tumor be soft and elastic, and if the patient be suffering from cystitis or retention of urine. Pressure and manipulation of the tumor may cause its disappearance, accompanied by a desire to urinate on the part of the patient. Vesical hernia must be especially distinguished from hydrocele of the cord.

Hernia of the bladder, by preventing proper evacuation of the organ, favors the occurrence of cystitis and of calculus, the latter often located in the incarcerated portion of the bladder. It should be treated on the same principles as govern the treatment of intestinal rupture.

Hernia of the bladder through a congenitally patent urachus has been rarely observed; the perviousness of this canal, without vesical hernia, is a more common affection. It should be treated by removing any obstruction to the exit of urine through the normal passages, or by artificial drainage through a perineal or suprapubic incision; after which the usual means for closing a fistulous opening—destruction of the lining epithelium by the actual cautery or chemical caustics—may be employed.

Inversion of the bladder through the urethra is a form of hernia occasionally observed in females as the result of violent straining; it is easy of recognition if the possibility of this condition be borne in mind. The bladder can be returned to its normal position under anæsthesia, but great care to prevent its recurrence must be observed.

Exstrophy of the bladder is a congenital absence of the anterior wall of the bladder, frequently associated with separation of the pubic symphysis and defect of the upper wall of the urethra; it is probably due to the same causes as epispadias, already described. The patient's condition is deplorable: the constant escape of urine, soon becoming ammoniacal, the excoriations of the skin as well as of the exposed bladder, contribute to a condition of constant suffering.

TREATMENT consists either in the wearing of a specially constructed urinal or in a plastic operation for the restoration of the defective tissues.

Kidney and Ureter.—*Absence of one kidney* is said to occur once in about four thousand cases: in at least one recorded instance a surgeon has removed the only kidney possessed by the patient, who presently died of suppression. Fortunately, the cystoscope now enables us to determine whether both kidneys are secreting urine.

Fusion of the kidneys, partial (horseshoe kidney) or complete, is an anomaly of little surgical importance.

A valve-like obstruction of the ureter at its junction with the kidney pelvis is the only congenital malformation of this duct possessing surgical importance. This valvular arrangement is apparently due to the insertion of the ureter into the pelvis at an improper angle, and its result is hydronephrosis.

A similar obstruction, due to "kinking" of the ureter, is occasionally observed as the result of displacement of the kidney and a consequent sharp bending of the ureter in its upper part.

Testicle and Vas Deferens.—*Absence* and *multiplicity* of these organs possibly occur, but with exceeding rarity.

A *eunuchoid condition* of the testicle is sometimes observed, the organ being of small size and lacking the normal glandular elements. Retained testicles exhibit this condition oftener than do those which have descended into the scrotum.

Misplacement of the testicle, due to irregular or incomplete descent, is a frequent and important malformation. The organ may be found in the abdomen (*cryptorchidism*), the inguinal canal, at the external inguinal ring, in the perineum or crural region. In any of these abnormal locations, except the abdominal cavity, the misplaced testicle constitutes a swelling which has often been mistaken for hernia, bubo, or abscess (the latter when the testis is inflamed by a gonorrhœal extension or other cause). Hence the surgeon should make a practice of examining the scrotum in every case of disease of the pelvic organs, that the misplacement of one or both testicles may not be overlooked. A misplaced testis can usually be recognized as such not only by its form and size, but also by the peculiar sensation caused by pressure upon it.

Misplaced or undescended testicles do not usually exhibit the perfect *structure* or *function* of the naturally placed organ: they are often found in a fibroid (eunuchoid) state, especially in middle life, secreting imperfect spermatozoa or none at all, though in the young such testicles have been sometimes found normal. If both testes be thus misplaced, the individual is sterile, though possessing normal sexual appetite and vigor; if only one testicle be undescended, the other, if normal, furnishes the spermatozoa essential to fertilization of the ovum.

Misplaced testicles, especially when retained in the inguinal canal, and hence subject to a continuous abnormal pressure, are *especially prone*

to *become the seat of malignant disease*—an argument in favor of opera-
tive interference.

If the testicle be retained in the abdomen, no treatment is required ;
if it be found in any other abnormal location, it should be *transplanted*
to the scrotum when possible. If this be prevented by adhesions or
shortness of the cord, its removal should be advised, provided the other
testicle be found normal. While the patient, when young, will usually
object to such removal, yet the frequent annoyance and pain from the
misplaced organ will gradually convince him of its advantages.

INJURIES.

Injuries of the genital and urinary organs require no treatment other
than that which aseptic surgery prescribes for injuries in general, *except
in so far as such injuries may open the urinary channels ;* for the reten-
tion in the tissues of urine which has escaped from the normal channels
is followed by severe *local sepsis*, with the ever-present danger of general
septic infection and intoxication. On the other hand, normal urine may
pass through or over any of the abdominal or pelvic tissues, even the
peritoneum, without especial injury or danger.

It is therefore the *stagnation of urine* in the tissues which must be
carefully avoided in the treatment of injuries that open the urinary canal
—if possible, by the prompt closure of the wound in the canal, and in
any case by provision for the free escape of such urine. If such drain-
age is provided, the same immediate results may be expected after
injuries of these as of other organs : as to the ultimate results, it must
be remembered that any channel through the tissues along which the urine
has long been allowed to flow is apt to become lined with epithelium
and constitute a permanent urinary fistula. Hence it is desirable to
close such wounds so soon as this can be done without danger of urinary
infiltration.

Penis and Urethra.—In treating injuries of the penis the great
vascularity of that organ must be remembered and care be taken to
arrest and prevent hemorrhage. Aside from wounds in general, which
need no description, the penis is sometimes the subject of *strangulation*,
dislocation, and *fracture* (so called). Strangulation occurs in boys or
men from tying strings or bands around the organ or introducing it
through rings or into bottles : great swelling, even gangrene, has been
known to ensue. Occasionally strangulation has been seen to follow
paraphimosis.

TREATMENT naturally consists in removing the constricting band
and in the liberal application of hot water to the swollen parts.

Fracture of the penis means a subcutaneous laceration of the erectile
bodies, usually the corpora cavernosa, and occurs through violence
inflicted on the rigid organ. It was often the result of an attempt to
" break " a chordee by striking the erect penis, previously laid upon a
table, with a book or other object ; and it has been known to result from
" missing the mark " in attempts at intercourse, the penis striking vio-
lently against the pubic bone of the female.

If neither skin nor urethra be lacerated, the hemorrhage from the torn vessels
of the corpus cavernosum makes a subcutaneous swelling which should be treated

with continuous hot fomentations. If, as more commonly happens, the urethra also is lacerated, profuse, even alarming, bleeding from the meatus ensues: this can be checked either by simple compression of the penis or better by compression against a large metal sound introduced into the urethra. For a day or two following this accident urination is apt to be difficult or even impossible, and the effort starts the bleeding again. Urinary infiltration is apt to occur, requiring free incision and drainage from without.

Laceration of the corpus cavernosum is in any case usually followed by obliteration of some of the vascular spaces in that body, and consequent imperfection in erection thereafter, the penis bending when erect toward the injured side.

Dislocation of the penis is a rare result of violence to these parts: the organ has been found displaced under the skin of the perineum, abdomen, or thigh. It should be immediately restored to its normal position and covered with skin, its own or that of surrounding parts (scrotum), when its original covering has been destroyed.

Injuries of the urethra may be clinically divided into those that do and those that do not extend through the skin, analogous to the compound and simple fractures of bones.

Injuries of the urethra combined with a wound of the overlying tissues and skin are usually inflicted by sharp instruments, and, because of the external opening, offer but little danger of urinary infiltration, though they may bleed profusely. *Longitudinal wounds* of the urethra heal whether sutured or not; *transverse wounds* should be sutured with catgut whenever possible. This is best done, after enlarging the wound if necessary, over a large catheter in the urethra. Sometimes the wound may have completely severed the urethra, rendering the introduction of a catheter difficult or impossible.

Fig. 209.

Traumatic stricture of urethra (by fracture of pelvis), with resulting hypertrophy of bladder-walls, ureteral dilatation, and hydronephrosis (Tuffier).

In this case, if the patient urinate freely through the wound, the surgeon may wait until the first swelling has subsided and then again try to pass the catheter; if, however, there is infiltration of urine, the sound urethra behind the point of injury should be made accessible—either by perineal urethrotomy or suprapubic cystotomy—and a catheter passed from behind forward, on which the urethra can be sutured. The tissues above the urethra may also be united, but a small drain should be left to prevent urinary infiltration. Transverse lacerations of the urethra and all injuries involving the peri-urethral tissues are apt to be followed by stricture.

Injuries of the urethra without perforation of the overlying skin are most common and often very serious. They occur in the penile urethra from fracture of the penis already described; from unskilful handling of metal sounds, catheters, and urethrotomes; from the introduction by

the patient of foreign bodies—needles, pencils, etc.; and from blows or falls. The less movable urethra posterior to the scrotum is, however, the most frequent site of such injuries, which result from the forcible use of urethral instruments, from blows and falls upon the perineum, and from fracture of the pelvic bones. Boys who have fallen astride of fences, limbs of trees, bicycle saddles, or other objects furnish a large share of these cases.

In a case of contusion of the structures surrounding the urethra, laceration of this channel is usually indicated by the escape of blood from the meatus; if, however, the urethral tear is located behind the bulb, the blood may not appear until urination occurs. Retention of urine almost always follows—sometimes immediately, at other times within a day or two; pain and swelling at the seat of injury are regular features.

The chief object of TREATMENT is to prevent urinary infiltration of tissues: the methods for accomplishing this will vary with the locality and extent of the laceration of the urethra. In cases of slight wounds of the penile urethra the introduction of a scrupulously clean elastic catheter (without a wire) at necessary intervals, whereby the urine is withdrawn and the urethra irrigated with hot water, may suffice. In some of these lesions of the anterior urethra, and in most cases of urethral laceration posterior to the scrotum, there will soon occur, in spite of this measure, the signs of beginning infiltration of urine—burning pain and boggy swelling at the seat of injury, rise of temperature, and ultimately chills.

So soon as the occurrence of symptoms justifies the belief that urine is stagnating outside of the urethra, the surgeon should insist upon making a prompt incision to the seat of rupture and instituting free drainage; incidentally he should endeavor to suture the wound in the urethra. Early operation not only greatly diminishes the chance of general septic infection and death (which has occurred in about 12 per cent. of such cases), but also, by limiting the local destruction of tissue, reduces the subsequent cicatrix and stricture-formation to a minimum. Physicians are inclined to wait too long before operating in these cases. Surgeons have even operated immediately after the receipt of the injury, without waiting for signs of infiltration.

If the *laceration be in the deep urethra*, the incision should be a perineal ure-throtomy, a drainage-tube being inserted into the bladder and retained for a week or ten days. In all cases where the urinary infiltration has been extensive, the continuous—or, if that be impracticable, the frequent—immersion of the parts in hot water is exceedingly valuable in cleansing the tissues and limiting the damage. Even the constant application of hot fomentations is useful when the immersion of the parts is for any reason impossible.

While the attempt to suture the lacerated urethra will not always succeed, yet by patience and ingenuity the surgeon may bring an unexpected amount of order out of the chaos of blood, urine, and fragments of tissue which is at first revealed by the incision.

The possible *remote results* of these injuries are extensive and obstinate stricture, urinary fistulæ, incontinence of urine from destruction of the membranous urethra, and curvature of the penis during erection from destruction of portion of the corpora cavernosa.

Bladder.—Injuries of the bladder may be clinically divided into two classes—those which do and those which do not *perforate* the wall of this organ. The latter usually proceed from rough instrumentation, and commonly result in nothing more serious than cystitis or possibly

sharp hemorrhage. Wounds involving the entire thickness of the bladder-wall are, on the other hand, most serious injuries, generally requiring prompt operative treatment. They are made directly by knives, bullets, fragments of fractured pelvic bones, etc. and indirectly by blows upon the hypogastric region, which compress the bladder when distended—the so-called "rupture of the bladder."

The danger from such injuries lies of course in the extravasation and stagnation of urine, either in the peritoneal cavity or in the extensive connective tissue of the pelvis which is subjacent to the peritoneum; in either case rapidly fatal septic infection and peritonitis are imminent. On the other hand, if the wound itself afford free exit to the urine, as when a bullet passes into the bladder or a stick is driven from the rectum or vagina into this organ, a free escape of urine resulting, septic infection often fails to appear.

It follows, therefore, that the first and immediate object of TREATMENT in all injuries by which the bladder is opened is to *provide free escape for the urine*. This may be secured by the insertion of drains through the wound itself; in other cases the wound must be enlarged and explored. Frequently the bladder should be opened by suprapubic incision, through which an attempt to close the wound in its wall can be made as well as perfect drainage secured: the exact measures to be taken must be determined in each case.

Rupture of the bladder usually results from violence to the suprapubic region when the bladder is more or less distended; in a few instances such rupture has occurred from violent straining and from distention of the organ by the surgeon as a preparation for suprapubic cystotomy. The possibility of this accident should be remembered in any case of injury to the lower abdominal region.

Ruptures of the bladder are practically divided into *intraperitoneal* and *extraperitoneal*, according as the tear does or does not involve that portion of the bladder covered by peritoneum. Intraperitoneal ruptures have all resulted fatally, usually within three days, unless promptly sutured after laparotomy; extraperitoneal ruptures are less certainly fatal, though the large majority die in a few days unless operated on.

It is evident, therefore, that even a decided probability of bladder rupture justifies an exploratory incision, which is far less dangerous than the delay often necessary before a positive diagnosis of rupture can be made. The surgeon should certainly never hesitate to operate when the first signs of septic infection become apparent.

SYMPTOMS.—These are by no means constant. Sometimes there occur frequent and painful micturition of a few drops of bloody urine, the catheter revealing an empty bladder, great pain and tenderness over the bladder, and signs of collapse. Yet in individual instances any of these signs may be absent: the patient may even pass fair quantities of clear urine; on the other hand, all the above symptoms may be present without rupture of the bladder; sometimes a catheter is felt to pass from the bladder into a cavity beyond, but this fortunate proof of bladder rupture is rare. Probably the most reliable test is the *injection into the bladder of hydrogen gas*, or, in its absence, of air: if there be an intraperitoneal rupture, no apparent distention is produced; if an extraperitoneal tear exists, an irregular distention of the suprapubic space

follows; if the bladder be intact, the familiar pear-shaped distention ensues.

TREATMENT.—So soon as the diagnosis of bladder rupture becomes probable—even though, as often happens, the surgeon cannot decide between intra- and extraperitoneal rupture—an incision should be made in the median line, extending from an inch below to two inches above the upper border of the symphysis. The peritoneum is not opened, but an opportunity is afforded to search carefully for an extraperitoneal rupture. If none such be found, the incision is prolonged upward sufficiently to enable the surgeon to open the peritoneum and examine the portion of the bladder covered thereby.

If an *extraperitoneal* rupture be found, the surgeon has a choice of three methods of treatment, exactly as in the operation of suprapubic cystotomy : (1) to suture the bladder wound (excluding the mucous membrane) and leave a drain down to the bladder ; (2) to leave the bladder rent open, inserting a drainage-tube therein ; and (3) to suture the torn edges of the bladder to the skin. The choice will be determined partly by the location of the tear, but chiefly by the condition of the urine. If this be aseptic, the first method should be employed ; if, on the other hand, the patient already has a septic cystitis, the second plan will be better.

If the rent in the bladder-wall be wholly intraperitoneal, the wound should be carefully sutured throughout its entire extent. When the rent is partly within and partly without the peritoneum, it should be completely sutured, and the bladder then attached to the abdominal wall for extra security against leakage of urine.

Sutures of the bladder should be of fine silk with the ends cut short ; they should be placed not more than a quarter of an inch apart, should extend beyond each end of the wound, and should not include the mucous coat ; the mattress suture should be used. After the seam is finished it should be tested by moderate distention of the bladder with water. Sutured wounds of the peritoneal surfaces heal very rapidly, those beyond the peritoneum less quickly and surely.

Kidney.—Injuries of the kidney are, for obvious reasons, always grave lesions : the extreme vascularity of the organ itself, its proximity to large blood-vessels and to the peritoneum, its vital importance to the organism, account for the heavy mortality accompanying serious injuries to its substance. Hemorrhage, sepsis, and peritonitis from the escape of urine have each resulted in many deaths. Clinically, we may divide injuries to the kidney into open and subcutaneous lesions, the former made by penetrating objects, the latter by falls, blows, and severe compression.

The SYMPTOMS of the open injuries, aside from the extent of the wound, are shock, nausea, and hemorrhage, the latter from the wound and through the bladder ; pain radiating to the testicles is sometimes observed. The escape of blood does not always measure the hemorrhage, however, as this may occur chiefly into the torn peritoneum or retroperitoneal connective tissue. Blood-clots may plug the ureter and cause colicky pain, as well as retraction of the corresponding testicle ; in the bladder clots cause vesical tenesmus and pain. Permanent blocking of the ureter causes either urinary fistula or atrophy of the kidney. The escape of urine into the perirenal tissues usually indicates a lacera-

tion of the kidney pelvis; it may be followed by extensive suppuration and sloughing.

The symptoms of subcutaneous rupture and laceration of the kidney are identical, except that the signs of severe hemorrhage and suppuration are necessarily more obscure; indeed, the admixture of blood with the urine may be first observed several days after the injury. Fluctuating swellings in the kidney region may gradually appear, composed either of blood (hæmatoma) or of urine, usually the former. Extensive ecchymoses, extending even to the scrotum, have been observed.

The TREATMENT of *injuries to the kidney* seeks to arrest hemorrhage and to prevent stagnation of escaped urine. The measures required to secure these ends vary with the extent and locality of the injury; and these, unfortunately, the surgeon is often unable to determine without

Fig. 210.

Gunshot wound of kidney, necessitating nephrectomy (Richardson).

manual examination of the kidney. Hemorrhage constitutes, of course, the more urgent demand for immediate interference; in cases where this is apparently slight no operative measures may be at first required, though the result may sometimes be death from concealed hemorrhage. If in a few days evidence of urinary infiltration becomes apparent, suitable incisions and drainage should be made.

In many cases severe hemorrhage compels immediate exposure of the kidney through a lumbar incision; and this would probably be the wise course in all cases of undoubted laceration of the organ. Bleeding from the kidney substance can be promptly checked by sutures of the kidney and of its fibrous capsules; hemorrhage from the large vessels compels ligature of the same, usually with removal of the kidney. Any lacerations of the kidney pelvis or ureter should be sutured with silk and

the vicinity thereof drained. Sometimes a septic cystitis is caused by decomposing blood-clots in the bladder, compelling drainage of this organ.

Wounds of the kidney substance heal rapidly: even if so extensive as to involve much of the organ, the opposite kidney will hypertrophy to any required extent. Wounds of the kidney pelvis heal more slowly, often requiring months, but the fistula usually closes ultimately without interference.

INFECTIONS.

An infection is a bacterial invasion of a living tissue—a growth of one or more species of bacteria in the tissue, with the local and general disease caused by the diffusion of injurious bacterial products.

The genito-urinary tract of the male frequently exhibits a primary infection by the following bacteria :

1. The *gonococcus ;*
2. The as yet undiscovered agent that produces *syphilis ;*
3. The *tubercle bacillus ;*
4. The various bacterial species that cause suppuration—a dozen or more in number—collectively termed the *pyogenic bacteria.*

1 and 2. **Gonorrhœa and Syphilis.**—The gonococcus, with the attendant pus-bacteria, producing the mixed infection known as gonorrhœa ; it and the syphilitic infection are discussed in Chapters X. and XI., Vol. I.

3. **Tuberculosis.**—The growth of the tubercle bacillus of Koch in various tissues of the genito-urinary organs is a frequent and most important primary infection of these organs, aside from the numerous cases in which the primary disease occurs in the lungs with secondary infection of the urinary passages.

By primary tuberculosis is meant the earliest perceptible tuberculous focus : it is of course always possible that infection of the bronchial nodes or other inaccessible parts may have preceded the outbreak of the disease in the genito-urinary tract.

Sites of Infection.—Primary genito-urinary tuberculosis usually first appears in the epididymis and the ejaculatory duct, less commonly in the kidney, yet it rarely remains long limited to these organs, the prostate and seminal vesicle soon becoming infected. In a very few instances tuberculous ulcers of the skin of the penis seem to have been the first manifestation (it is possible that some sores called chancres, and not followed by syphilis, have been tubercular ulcers).

Avenues of Infection.—The possibility must be admitted that the fœtus at birth may contain tubercle bacilli, yet opportunity for infection after birth is so general that this seems the more plausible explanation. It is probable that infection of the genito-urinary organs is practically always by one route—the blood-current— whereby the bacilli are brought from lungs, intestines, or old foci in the cervical and bronchial nodes.

The idea that intercourse with a woman suffering from tuberculosis of the pelvic organs can cause the ascent of tubercle bacilli along the male urethra to the prostate is fanciful and utterly without proof. That such intercourse may inoculate the skin of the male genitals, with subsequent lymphatic transfer to the pelvic organs, is demonstrated, and it is probable that the urethra and prostate have been occasionally infected by urethral instruments. Yet since a large percentage of genito-urinary tuberculosis occurs in youths who have never had intercourse nor been subjects of urethral instrumentation, we must consider the blood-current the usual avenue of infection.

Age of Patients.—The liability of the genito-urinary tract to active tuberculosis begins with puberty, and is especially manifest during the succeeding ten or fifteen

years. While, therefore, tuberculous nodules have been demonstrated in the epididymis of children prior to puberty, and while tuberculosis has been observed in the genital organs of elderly men, nearly all cases of genito-urinary tuberculosis first attract attention between the ages of fifteen and thirty-five. Yet since the disease rarely causes pain until the mucous surface of prostate or bladder is invaded, it may exist for years in the other organs without causing the patient to seek medical advice.

Predisposing Influences.—Among the factors which favor the lodgement of the tubercle bacilli are—that ill-defined vice of nutrition that we term hereditary predisposition, injury, and possibly gonorrhœa. Yet genito-urinary tuberculosis is frequently found in robust, athletic subjects, in whose history none of these predisposing factors can be traced; and this is a fact of importance, because we are apt to think that a patient cannot be tuberculous without being cachectic.

The SYMPTOMS and TREATMENT will be considered under the diseases of the respective organs.

4. Sepsis.—The urinary channels are peculiarly exposed to the entrance of bacteria by way of the blood-current, the urethra, and the rectum. Yet it seems that septic infection of the normal urinary tract does not occur—in other words, that suppuration in this tract is always preceded by some impairment of nutrition whereby the natural tissue resistance is depressed. Many examinations have demonstrated that the normal urinary tract from kidney to prostate is absolutely sterile, and, though the normal urethral surface is known to harbor many pus-bacteria, yet they fail to enter its tissues until these have been disturbed by some other agency. Hence cystitis, urethritis, and pyelitis are terms expressing results rather than primary conditions.

When the natural vitality of tissues is lowered by any agency, such as the growth of the gonococcus or tubercle bacillus, the stagnation of urine in the bladder caused by a tight stricture or prostatic enlargement, the pus-bacteria—which easily gain access by one of the routes mentioned—may infect a part or the whole of the urinary tract.

Examination of Patients.—The information elicited is *subjective*, given by the patient, and *objective*, ascertained by the examiner. The patient should be questioned as to the frequency of urination by night as well as by day; as to the locality and frequency of pain in urination; whether micturition is urgent; whether there is involuntary escape of urine; and whether this fluid has been observed to contain blood or pus. The age and occupation of the patient, the duration of his ailment, antecedent diseases (especially gonorrhœa, syphilis, sexual excesses, and dyspepsia) should be the subject of inquiry.

The information given by the patient may or may not indicate the seat and nature of the trouble; the examiner should learn to depend upon his own investigation rather than upon the patient's statements. The instruments required for such examination are fingers, eyes, bulbous sounds (or urethrometer), conical sounds, endoscope, cystoscope, microscope, and thermometer.

In every case except recent gonorrhœa a complete examination should be made; the temperature should be taken; the heart and blood-vessels examined; the external genitals, particularly the prepuce and meatus, inspected; the testicle, epididymis, and spermatic cord felt between thumb and finger; the suprapubic and renal regions percussed and palpated; the posterior surface of prostate and bladder explored by the *finger in the rectum*. The last-named measure is an extremely important though often-neglected means of diagnosis: the examining finger should carefully note the size, consistence, smoothness, and symmetry of the prostate, and whether the normal notch between the upper ends of the lateral halves is distinct; the size, consistence, and tenderness of the seminal vesicles and ampullæ should also be observed. Pressure with the other hand above the symphysis brings these organs nearer to the examining finger.

The patient is required to urinate into three small glasses—say a half ounce each into the first and second ; then the examiner introduces the finger into the rectum and gently presses the prostate and seminal tubes, after which the patient passes the remainder of his urine into the third glass. The first of these glasses contains the washings of the urethra, the second a fair specimen of the bladder urine, and the third the products of the prostate and seminal tubes.

In many cases—as of tuberculosis, chronic gonorrhœa of the prostate and appendages, malignant disease of the prostate—the diagnosis is established by the measures already mentioned. Yet unless there is some special objection the internal examination of the urinary passages should follow. First, the calibre of the urethra as far as the bulb is examined by means of bulbous sounds or the urethrometer, and strictures carefully noted ; then a metallic sound of large size and short beak (15 to 17 of the English scale, unless strictures compel a smaller size) is passed carefully through the deep urethra.

To examine the cavity of the bladder this organ should be washed out and then distended with about five ounces of warm sterilized water or very weak antiseptic solution ; a short-beaked sound can then be introduced, the handle depressed below the level of the symphysis, and the instrument rotated on its axis in the search for a stone. If the cystoscope be used, the sound can be dispensed with, as the former instrument is a good stone-searcher : by means of the cystoscope the surgeon inspects not only the interior of the bladder, but also the orifice of the ureters, noting the frequency of the ureteral discharges into the bladder, as well as the appearance of pus or blood from these orifices. Finally, the endoscope may sometimes be required for the determination of the condition of the urethral mucous membrane.

The urine obtained should always be submitted to the usual chemical tests, and when necessary examined with a microscope for pus, blood, epithelium, crystals, and the pus for tubercle bacilli or gonococci.

In special cases it is best to obtain the washings of the anterior urethra by introducing a soft catheter to the bulb, and irrigating this channel before the patient urinates ; after which the urine may be passed into three glasses as above described.

Diseases of the Penis and Urethra.

Penis.—Aside from injuries and malformations (already described), diseases of the penis are commonly associated with, and often proceed from, diseases of the urethra. The skin of the penis is the seat of various innocent affections which, because of the extreme sensitiveness of the patient to any abnormality of the genitals, often occasion needless alarm. The most frequent of these are *herpes, warts*, and *scabies*.

Herpes is a not infrequent disease, the vesicles appearing on the inner surface of the prepuce and in the furrow behind the gland. At times it is evidently favored by obvious conditions, such as a tight prepuce, lack of cleanliness, or a gleety discharge ; in other cases no local cause can be detected, and it is assumed that the disease is due to gouty or neurotic influence ; in these cases it is often recurrent. The vesicles usually follow the same course as herpes elsewhere ; sometimes, however, they ulcerate obstinately.

It is always important and sometimes difficult to distinguish herpes from *venereal sores ;* the difficulty arises in cases of obstinate ulcerating herpes. Indeed, it may happen that a genuine chancre or chancroid develops on the site of the herpetic blister, the patient having unfortunately exposed himself during the course of the herpes and having received the infection at that spot.

The TREATMENT of herpes is local and general, the former consisting in the removal of the obvious local causes already mentioned, and in the application of liquid thyol or oleate of zinc on a thin layer of cotton inserted between prepuce and glans. The general treatment attempts to correct the gouty, neurotic, or other unhealthy tendencies of the patient. In cases of persistently recurrent herpes circumcision is often needful to a cure.

Warts (pointed condylomata) of the prepuce and glans are often developed during or after gonorrhœa, and sometimes without apparent cause. They may be snipped off with scissors and their bases cauterized with nitrate of silver; a less objectionable but longer method is the daily application of liquor arsenicalis or of acetic acid. Under its use the wart shrivels, dies, and drops off.

Scabies appears on the penis and scrotum very early after its acquisition on the hands; it needs only to be recognized in order to be successfully treated with suphur or naphthol.

Cavernitis, acute and chronic inflammation of a corpus cavernosum, may result from gonorrhœa, mechanical injury to the penis or urethra, or syphilis. The chronic cases are not uncommon, attracting the patient's attention by localized tenderness and hardness of the penis and especially by the curvature of the organ when erect.

The TREATMENT consists of local inunctions of mercurial ointment, with massage, and of the iodides internally if the patient be syphilitic. Such treatment commonly secures a decided improvement in the symptoms in the course of a few weeks.

Gummata of the penis occur either in the cavernous bodies or in the furrow between them. Distinct nodules in this locality should always arouse the suspicion of syphilis and lead to specific treatment.

Epithelioma of the penis usually begins as a warty growth at or near the sulcus, sometimes on the body of the organ. It occasions but little pain until ulceration occurs; local extension and lymphatic infection are slow. It must be carefully distinguished from ulcerating gumma, which is far more common and has often been erroneously called cancer; syphilitic treatment will soon decide a doubtful diagnosis.

The TREATMENT should consist of *amputation* of the penis at least a half inch behind the nearest point of infiltration; less radical measures, such as excision of the growth, usually fail and waste valuable time. Careful examination of the inguinal nodes and thorough removal of all, if any seem infected, should be made at the same time.

In amputation through the body of the penis the skin and urethra should be cut a half inch longer than the corpora cavernosa, the urethra split front and back, and its edge stitched to the cut edges of the skin. If the cancer extends close to the symphysis, the entire penis must be removed, the corpora cavernosa being dissected from the pubic bones; in such cases the scrotum and testicles should also be ablated. Care must be taken to preserve the membranous urethra, which is the chief sphincter of the bladder, and the cut edges of the mucous membrane should be united with those of the skin.

Urethra.—The *diseases of the urethra* not yet described are chiefly ulcers, vegetations (polyps), chancres, and strictures. Cancer of the urethra is exceedingly rare, only about a dozen cases having been as yet demonstrated.

Ulcers of the urethra occasionally persist after gonorrhœa, and may

be responsible for a slight gleet. They can be seen through the endoscope, and touched with copper sulphate or other astringent. Thorough stretching of the urethra is usually necessary to cause the absorption of the inflammatory exudate surrounding the ulcer; indeed, there is no doubt that this alone has often secured healing.

Vegetations and polyps are sometimes discovered in connection with a gleet; they can be detected and treated only through the endoscope. The larger ones (polyps) have been snared or torn off, the smaller ones withered by careful application of the liquor arsenicalis or acetic acid.

Chancres occur in the first half inch of the urethra, doubtless far more commonly than is generally supposed. They cause a slight purulent discharge and some smarting on urination—symptoms which are assumed to indicate a mild gonorrhœa. The surgeon should make a practice of separating the lips of the meatus and inspecting the urethral surfaces in every case of mild urethritis; endoscopic examination is more complete.

Strictures of the urethra are portions of the canal whose dilatability is less then normal; they have usually been classified as *spasmodic, inflammatory,* and *organic.*

The term *spasmodic stricture* is applied to a narrowing of the channel due to a supposed spasmodic contraction of the muscular fibres encircling the urethra.

While such spasm is doubtless possible—at least in the membranous portion—the obstruction often met at the bulbo-membranous junction and ascribed to spasm is frequently due to unskilful handling of the instrument; this is not made to follow the natural curve of the urethra, and hence strikes against the firm triangular ligament just behind the bulb. The more skilful in catheterism the surgeon becomes, the less frequently he discovers "spasmodic stricture."

The term *inflammatory stricture* designates the swelling of the tissues during gonorrhœa, and is properly becoming obsolete.

Organic stricture—the only persistent and properly styled narrowing of the urethra—means a diminution of the normal distensibility of this canal by an overgrowth of the submucous connective tissue, which may be either congenital or acquired as the result of any inflammatory process, lacerations by instruments or by fragments of calculus, blows and crushing injuries, and severe urethritis.

According to their etiology, organic strictures are usually classified as *traumatic* and *gonorrhœal:* this division has been perpetuated because it was formerly supposed that all strictures not traumatic resulted from gonorrhœa.

It is now known that many strictures exist in men who have never had gonorrhœa, but who, having never sought advice for urinary troubles, were formerly not examined for stricture; and it is reasonable to believe that many strictures which are detected only when the patient comes to be treated for gleet were present prior to that disease. It is certain that strictures of the first half of the urethra are often found in men who have never had gonorrhœa; some of them, at least, are congenital, due to the incomplete removal of the connective-tissue partition which in early fœtal development separates the penile from the glandular urethra.

A more rational—and clinically important—classification of strictures is into *traumatic* and *non-traumatic*, the latter class including congenital and gonorrhœal strictures.

Organic strictures may be present at any time of life, but are most frequently detected between the ages of twenty and forty-five. In the last decades of life strictures become far less troublesome than in middle life, possibly from the proneness of the fibrous tissue to undergo fatty degeneration. For anatomical reasons women suffer less frequently from urethral strictures than do men.

When arising from gonorrhœa or other urethral inflammation a considerable time—one to several years—elapses between the occurrence of the inflammatory process and the consolidation of the exudate into firm connective tissue, and its contraction to a degree which materially impedes the exit of urine; hence many strictures exist for years before the patient becomes aware that something serious ails the urethra. Traumatic stricture, on the other hand, due to mechanical injury, contracts very rapidly—in a few weeks or months—to such a degree as to require treatment.

The *location of a stricture* may be anywhere from the meatus to the membrano-prostatic junction; strictures of the prostatic urethra are practically unknown. Probably the two most frequent sites of stricture are the bulbo-membranous and the glandular portions. Several strictures may coexist in different portions of the same urethra.

The *calibre of a stricture* means the distensibility of the urethra at the strictured point, and is expressed in terms of the French or English catheter scale.

Otis proved that the distensibility of the normal urethra was much greater than had formerly been supposed—that in the average man it ranges from 30 to 34 of the French scale; and he was inclined to attach much pathological importance to slight narrowings of the canal below this size. For several years his disciples ascribed many disorders of the genito-urinary tract to these alleged "strictures of large calibre," and they attempted to cure such troubles by a rather generous practice of internal urethrotomy. Later experience has shown that the distensibility of the normal urethra varies decidedly in different parts of this canal; that many of the so-called strictures of large calibre are normal structures; and that their division fails to cure anything.

The term "stricture" should be applied only to an overgrowth of submucous connective tissue which causes an unnatural rigidity of the urethral wall. While in certain individual cases opinions might differ as to the propriety of applying the term "stricture" to a given urethral narrowing, yet there is general agreement that slight narrowings of the urethra may be ignored as pathological entities; the term "strictures of large calibre" may be applied to narrowings of the canal which permit a No. 20 French instrument to pass.

Effects on Urethra.—At the strictured point the urethra may present but slight changes from the normal condition; behind the stricture, however, marked changes ensue, which become more pronounced as the calibre of the strictured part decreases. These changes are largely due to the pressure of the urine, which is arrested by the stricture and distends the urethra behind it; moreover, a few drops of urine are apt to remain and decompose behind the stricture. The mucous membrane becomes thinned, atrophied, and, though deeply congested, its epithelium becomes eroded; superficial and then deeper ulceration ensues, and finally the urine escapes into the surrounding tissues, making peri-urethral abscesses and fistulæ.

The COURSE of a stricture is constantly toward contraction, at least until the patient becomes fifty or more years old, when fatty degenera-

tion is apt to ensue; the connective-tissue mass becomes firmer and harder, resembling cicatrix. The body of this cicatricial tissue is apt to be on the floor rather than the roof of the urethra, so that the *opening through a stricture is frequently on the upper side of the canal.*

Traumatic strictures differ anatomically from the non-traumatic only in degree; the mass of new connective tissue is larger, its contracting tendency greater, and hence the difficulty in maintaining the patency of the urethral canal greater. Traumatic strictures are as a class very obstinate and difficult to treat.

SYMPTOMS.—The morbid phenomena produced by urethral strictures vary in details according to the location and extent of the contraction, but two very frequent results require special mention :

(*a*) *Effects upon Micturition.*—These are especially three—(1) increased frequency of the act (by night as well as by day); (2) diminution in size and force of the stream ; and (3) dribbling at the end of urination.

These obvious results of a decided narrowing of the channel are far more pronounced when the stricture is situated in the bulbo-membranous region than when it is in the anterior portion. Various other phenomena are often observed, such as a muco-purulent discharge from the meatus, a scattering of the urinary stream, pain during seminal omission, dribbling of semen after subsidence of erection, imperfect erection, and premature ejaculation.

(*b*) *Prolongation of a Gleet.*—One of the frequent causes for the persistence of a gleety discharge, in spite of various injections and internal medications, is the morbid condition of the strictured urethral wall.

At and behind the narrowed point the epithelial lining as well as the submucous tissue is in a state of chronic inflammation, with catarrhal discharge, and the urethra in this region fails to contract and empty the urine after each micturition; hence more or less urine is retained in contact with the surface back of the stricture, keeping up a constant irritation.

DIAGNOSIS.—In every case of gleet or of disordered micturition examination of the distensibility of the urethra should be made ; indeed, such examination should be a routine part of the investigation of almost every case of chronic urinary or genital disorder. Narrowing of the urethral canal may be detected by bulbous sounds (*bougies à boule*) when the meatus is sufficiently large to permit their introduction. When the meatus is abnormally small (less than 22 French) the surgeon must either enlarge this opening by incising its lower angle or use a specially constructed dilating bulb, called the *urethrometer,* which can be introduced closed through the narrow meatus and expanded within the canal. For reasons previously mentioned division of the meatus should be in general avoided.

The bulb, well oiled, is introduced into the freshly irrigated urethra ; if it pass freely, a larger one is used ; and finally a 30 or 32 French is introduced if the smaller instruments have failed to detect any narrow point. These bulbs should not be passed farther than the bulbous urethra ; the remainder of the canal is examined by the ordinary conical sounds. If the urethrometer is used, it is introduced closed to the bulb of the urethra ; the expanding portion of the instrument is then dilated to 30 or 32 French, and gently drawn toward the meatus ; if obstruction is met, the bulb of the instrument is reduced until it passes the obstruction, and then again dilated and further withdrawn. By these instruments the location and extent of urethral contractions can be determined.

TREATMENT.—The restoration of the urethral distensibility is of course the object of treatment; and it should be understood that by all methods heretofore employed such restoration is usually imperfect and temporary. While by treatment the symptoms produced by stricture can usually be abolished, yet an anatomical cure is probably unknown; hence it follows that a recurrence of the contraction and of the symptoms produced by it are frequent. A young patient who has a stricture should be informed that even after thorough dilatation the stricture is apt to recur in a few years and need a repetition of the treatment, and that such recurrences will probably continue until he has passed the age of fifty or fifty-five years.

There are two principal methods of treatment of urethral stricture—*gradual dilatation* and *incision (urethrotomy);* and two subordinate methods of only limited application—*electrolysis* and *massage.*

Gradual Dilatation.—This is the ideal treatment; it is successful in most cases of non-traumatic stricture, and should be regularly employed; in comparatively few cases, to be presently mentioned, it fails.

The value of gradual dilatation consists not in the direct spreading of the narrow portion, but in the fact that this stretching is followed by a pronounced congestion and exudation into the stretched portion, whose resolution includes the absorption of some of the connective tissue constituting the stricture. The repetition of this process every three or four days by the introduction of sounds of gradually increasing size causes ultimately a more or less complete removal of the strictured tissue.

Urethrotomy was formerly much employed, but is now generally reserved for cases in which dilatation is ineffectual, because of the extreme hardness, extent, and bloodlessness of the stricture tissue. There are three classes of strictures in which urethrotomy must often be done: (1) *traumatic strictures* of the perineal urethra; (2) *strictures of the glandular urethra*—that is, within a half inch of the meatus, for experience shows that dilatation is often ineffectual in these cases; and (3) *cases in which extravasation of urine has occurred,* compelling incisions for drainage. While, therefore, urethrotomy is required in a majority of cases of stricture, it should be reserved as the treatment of necessity: the method of choice should be always gradual dilatation.

Internal urethrotomy—incisions by an instrument introduced within the urethra—is not without danger, the mortality being at least 2 per cent.; if the blade perforates the basement membrane, there is a great chance of severe hemorrhage and of urinary infiltration, followed by local abscess and even by general septic infection; after recovery the penis may exhibit a pronounced curvature when erect, due to local destruction of the cavernous tissue. These unpleasant complications are especially probable if the cut be made on the roof of the urethra.

These objections do not obtain in cutting strictures within a half inch of the meatus, the only locality in which internal urethrotomy is advisable; for here the incision made on the floor of the urethra should be extended through the meatus, thus affording perfect drainage and eliminating the danger of abscess and of septic infection; nor can the hemorrhage be serious from such a cut.

It must be remembered that the entrance of morbid urine into the tissues may be followed by acute intoxication, severe and even fatal; this may occur within twenty-four hours, before suppuration has developed, and is due either to substances preformed in the urine or to a peculiarly acute bacterial infection. While less common than ordinary septic infection, it does sometimes follow internal urethrotomy, and constitutes an additional warning against this operation.

If an old stricture of the penile urethra should be found undilatable, a combined operation—internal urethrotomy and external perineal urethrotomy—should be made: the urine is thus prevented from entering the wound in the penile urethra, because drained out through the perineal tube, and the dangers of urinary infection are thus avoided.

External Urethrotomy.—In the deep urethra internal urethrotomy should never be made, for extravasation of urine is very probable and very serious, the firm fascia of the triangular ligament confining the septic material. When it becomes necessary to cut a stricture of the deep urethra (many traumatic strictures cannot be dilated without severe laceration) *the cut should always be made from the outside*—an external urethrotomy or *perineal section*. After complete division of the stricture, as shown by the passage of a large sound from the meatus, a drainage-tube is carried into the bladder and permitted to remain from six to ten days.

Treatment is continued by gradual dilatation with conical instruments, the narrow point of which is passed through the strictured canal, after which gentle pressure forces the tapering portion into the gradually widened channel The instruments may be elastic (bougies) or metallic (sounds); the former are preferable for long or multiple strictures, though their surfaces are rougher than the polished metal. In general, straight sounds with conical tips are best for the penile urethra, and curved sounds for the deeper portion. The calibre of the stricture having been ascertained by the bulbous sounds, the surgeon selects a conical sound whose point is smaller and shaft about two (French) sizes larger than this calibre. The patient being in the recumbent position (no urethral instrumentation should be performed in any other position), the urethra having been well irrigated and the instrument lubricated with clean vaseline, the sound is gently introduced until the conical extremity is felt to be through the stricture, the instrument being "engaged" therein; the penis meanwhile is stretched along the sound so as to obliterate transverse folds. Steady but gentle pressure for a few minutes or less will force the shaft through. The judgment of the surgeon must determine the amount of force that can be used; in general, a gentle pressure for a longer time is far superior to severe pressure for a few seconds. The instrument is allowed to remain in the stricture for a quarter or half minute, than gently withdrawn. Three or four days later a sound one or two French sizes larger is introduced in the same way: this will be facilitated if the surgeon first passes the sound used at the last sitting, and follows it in a few minutes with a larger size. The gradual dilatation should be continued at successive sittings, three or four days apart, until a 30 to 34 French (according to the size of the urethra) passes freely.

During the first twelve or twenty-four hours following the passage of the sound there is often sufficient swelling of the strictured tissues to cause a noticeable diminution in the size and force of the stream; after this the flow of urine is decidedly better than before the use of the instrument. Care should be taken not to use much force, lest three unpleasant results follow: (1) sufficient laceration to cause annoying bleeding; (2) great soreness at the site of stricture for several days, often with purulent urethritis; and (3) chill and fever, one of the forms of "urinary" or "urethral" fever. It is true that chill and fever may follow the gentlest instrumentation in the urethra, especially in the prostatic portion, but the chances for it are greatly increased by the forcible use of instruments.

In two classes of cases special instruments and measures are required for the execution of gradual dilatation: these are *cases of very tight and narrow stricture*, and *cases in which the meatus is unduly contracted*.

Tight and "Impermeable" Strictures.—In consequence of the patient's neglect to seek assistance, the connective tissue constituting a stricture may have contracted so much as to almost occlude the urethral canal, permitting the passage of urine only in a very fine stream or even by drops. If the subject of such a stricture becomes chilled through

exposure or indulges to excess in alcoholic drinking, he may suddenly find himself absolutely unable to void urine. Such strictures are usually amenable to gradual dilatation, provided an instrument can be made to pass the narrow portion; this attempt must be made by filiform bougies. Formerly, such bougies were made of the same diameter throughout; the later form, called the "whip," is far more useful: it is filiform for several inches of its length, and then gradually increases in size to 12 or 15 of the French scale.

When called upon to treat a tight stricture, impermeable to ordinary bougies, the surgeon should first—especially if there be a history of recent and sudden diminution of the stream due to œdematous swelling of the stricture—apply hot water freely to the penis and perineum, both externally by baths or fomentations, and internally by injections. Then olive or castor oil is injected into the urethra and retained by closing the meatus; a *filiform* (or, better, a whip) bougie is gently introduced, the penis being drawn taut so as to obliterate transverse folds of the urethra. And now begins what is often a test of patience for both surgeon and patient: the filiform is gently advanced to the stricture and trials made to make its point find the minute opening in the same. Sometimes success is immediate; more frequently repeated trials, continued for many minutes, are made before the instrument passes. Only gentle force should be employed, since undue violence may result in puncturing the urethra (a false passage) or in doubling the end of the filiform. If the ordinary filiform finally passes freely beyond the stricture, an effort should be made to pass a second along the side of the first, which should on no account be withdrawn, lest the surgeon have to repeat the tedious and painful performance. The filiform should be tied to the pubic hair or to a strip of adhesive plaster attached lengthwise to the penis, so that it cannot be forced out, and should be allowed to remain for twenty-four hours. At the end of this period the calibre of the stricture will be much increased, so that a small bougie can probably be passed without trouble and gradual dilatation begin. If the first instrument introduced be the whip bougie, it should be passed in until the expanded portion has been forced into or through the stricture,

FIG. 211.

Rupture of urethra behind a tight stricture; death from rapid infection (Guyon and Bazy).

thus enlarging the contracted part at once to a size which will permit the passage of a small bougie. The patient should be warned that the urinary stream may become very small a few hours later, and instructed to sit in hot water if he should have difficulty in expelling the urine.

If all efforts to pass the stricture fail, the surgeon may make a perineal urethrotomy, and, passing a small bougie into the urethra through

the incision, approach the stricture from behind. If the impermeable part happen to be the membranous urethra, he must either make a perineal section without a guide or a suprapubic cystotomy, and catheterize the urethra from the bladder.

When the meatus is unduly small, strictures may be stretched by means of special instruments constructed on the principle of the dilating bulb, called *urethral dilators.*

The barbarous and dangerous method of rupturing the stricture, formerly in vogue under the name of "divulsion," *should never be employed under any circumstances.*

The treatment of stricture may be thus summarized : Gradual dilatation is the preferred and generally successful method ; in tight strictures within half an inch of the meatus, and in tight strictures (especially traumatic) of the bulbo-membranous region, dilatation may fail. In this case internal urethrotomy on the urethral floor should be made in the former, and external perineal urethrotomy in the latter cases. Very tight strictures should be rapidly dilated by the whip bougies to 10 or 12 French, after which gradual dilatation is performed.

Urinary Fever.

Instrumentation in the urethra and bladder is often followed by chills and high fever—phenomena variously termed urethral, catheter, or (best) urinary fever. These unpleasant symptoms most frequently follow lacerations of the mucous membrane, but can undoubtedly occur when no evidence of such laceration can be detected. The clinical course of urinary fever is variable : sometimes all morbid phenomena disappear in twenty-four hours ; sometimes they last for several days ; and in some cases—especially after the sudden evacuation of the chronically distended bladder of the patient with enlarged prostate—the fever assumes a typhoid aspect and continues until the patient's death, a few weeks later.

It is evident that the term urinary fever includes several distinct morbid conditions ; these are—

1. *Intoxication,* through lacerations of the mucous membrane, with poisonous substances in the urine ;

2. *Infection of the blood-current,* through such laceration, with septic bacteria ;

3. *Infection of the urinary passages*—bladder, ureter, and kidney— with septic bacteria ; a suppurative cysto-pyelitis ;

4. *Acute congestion of the entire urinary tract*—the so-called *hyperæmia ex vacuo*—from the change in pressure by sudden withdrawal of the urine in cases of habitually distended bladders : this occurs when the catheter is first used in old men with prostatic enlargement, whose bladders have long been distended ; and

5. (Possibly) a *reflex nervous action :* this seems plausible, because the chill sometimes follows so quickly upon the instrumentation that any one of the foregoing conditions seems improbable.

The avoidance of urinary fever should be attempted by—

1. *Gentleness* of all intra-urethral and intra-vesical manipulations, whereby the chance of lacerating the mucous membrane is diminished ;

2. *Careful irrigation* through a soft catheter of the anterior urethra,

and (when septic infection of the bladder already exists) of the deep urethra and bladder before metal instruments are introduced;

3. In cases of chronically distended bladders, such as result from prostatic enlargement, the physician should be careful, if called upon to introduce the catheter for acute retention or other cause, *never to evacuate the bladder completely at the first sitting:* a portion only of the urine should be withdrawn, and the bladder gradually emptied by repeated catheterism during several days.

Internal Urinary Antiseptics.—It was formerly supposed that the dangers of urinary infection could be much lessened or even abolished by the internal administration of antiseptic substances which are eliminated by the kidneys, such as salol and boric acid. This theoretical hope has not been fully realized in practice: though either of these substances may be properly administered in five-grain doses every four hours, yet the surgeon should not place the least dependence upon the avoidance of infection thereby, nor be lulled into omitting any of the far more important local measures to the same end.

DISEASES OF THE PROSTATE AND APPENDAGES.

THE *prostate*, its *utricle*, the dilated extremities of the *vasa deferentia* (called *ampullæ*), and the *seminal vesicles* are, like the uterus and tubes of the female, enclosed in a thin fibrous sheath which I have called the *broad ligament of the male.*

There is one notable difference, however, between male and female, in that the peritoneal covering of this sheath in the female is reflected from its top down its anterior surface before rising again on the posterior surface of the bladder, while in the male the peritoneum crosses directly from the top of the broad ligament to the bladder. There is, therefore, in the male no peritoneal pocket corresponding to Douglas's pouch in the female, the sheath of the seminal tubes being adherent to the bladder; but the essential part of the broad ligament, the fibrous sheath, is found in both sexes alike.

Recognition of this anatomical homology suggests a clinical analogy which experience shows to be well founded—namely, that infectious and suppurative processes extend from prostate to seminal tubes and the enclosing fibrous tissues, just as they are known to extend from uterus to the tubes and broad ligament. Hence we may properly speak of many diseases of the prostate and seminal tubes and vesicles collectively, designating these structures, for brevity's sake, as the "prostate and appendages."

Infections.—The most common of these is the gonorrhœal (see Vol. I. Chap. XI.); indeed, this disease and its complications furnish practically all examples of acute infection of these parts.

The *chronic* infections are *gonorrhœal, septic,* and *tuberculous,* of which the first named has been discussed in Volume. I.

The chronic septic infections of the prostate and seminal tubes, when not gonorrhœal, are caused by urethral *instrumentation, caustic urethral injections,* by *extension* from chronic urethritis due to tight stricture of the deep urethra, by extension from a cystitis, and probably some are caused, especially in middle-aged or elderly men, by *prostatic calculi.* They are favored by the chronic venous congestion of the pelvic organs

which is so common in elderly men as the result of constipation, alcohol-drinking, high living, and lack of exercise.

The *chronic tubercular infection* of these organs is usually associated with tuberculosis in the *epididymis*, and, while often primary in the clinical sense, is perhaps usually derived from slumbering infections in cervical or bronchial nodes, etc.

Clinically the septic infection is still usually termed chronic prostatitis, and the tubercular infection, tuberculosis of these organs.

Chronic prostatitis—which is really a chronic septic infection of the prostate and appendages—is due to one of the causes just mentioned, which renders the tissues a favorable soil for the growth of the pus-bacteria. It is often the sequel of an acute infection, but very commonly also a chronic inflammation from the start.

SYMPTOMS.—There is dull pain in the perineum, suprapubic region, rectum, and sometimes in the glans penis, aggravated by jolting or sitting on upholstered chairs; pain in the sacral region (which the patient usually ascribes to his kidneys) is at times the most prominent feature. Urination is apt to be unduly frequent, and is sometimes followed by the escape of a viscid grayish or watery fluid (from the prostatic glands) which the patient commonly considers semen. Sometimes there is a continuous slight discharge of similar fluid from the meatus—the so-called "prostatorrhœa." Sexual desire is often decreased and the normal pleasurable sensation much diminished or even absent; ejaculation is often premature, and erections may be feeble or may subside before emission occurs. The patient is often extremely despondent.

This is really the *condition of incipient impotence*, and leads ultimately to practical loss of virility. Often the patient complains of the sexual symptoms only, while the others are elicited upon questioning.

Examination with the fore finger (best enclosed in a rubber condom) discloses a sensitive and perhaps swollen condition of the prostate or seminal tubes, or of both, with more or less thickening of the connective-tissue envelope of these organs; in pronounced cases the recto-vesical space is a rather hard and sensitive mass in which the ampullæ and vesicles are not distinctly perceptible. Gentle stroking or *milking* of these parts toward the anus is soon followed by the appearance at the meatus of considerable fluid containing a more or less distinct admixture of pus.

TREATMENT.—This will naturally begin with the removal of the cause of the trouble when this is practicable; thus, a tight stricture must be dilated, a foreign body in the bladder removed, etc. The treatment directed especially to the prostate and appendages is the following: avoidance of constipation and of alcoholic and sexual excesses; the milking of the recto-vesical organ by gentle stroking with the finger-tip in the rectum toward the anus; this process is continued for three to five minutes and repeated every six or seven days unless vesical irritation is induced, when the intervals are made longer. A large sound should be passed into the bladder once a week, its straight portion entering the prostate; deep injections of silver-nitrate solution (two ounces of a 1 : 3000 solution) once a week are helpful. The despondency of the patient should not be ignored; a cheerful prognosis and tonic remedies are useful.

The local treatment will usually show early results in the removal of the sacral and suprapubic pain, improvement in urination, and the

cessation of discharge; the restoration of the sexual functions generally requires a prolonged treatment.

Enlargement (Hypertrophy) of the Prostate.—The familiar condition designated by each of these names includes two anatomical states: (1) *a diffuse enlargement of the prostate*, and (2) *localized hypertrophies of its glandular and muscular tissues*, which project into the bladder.

The *diffuse enlargement* is certainly often and probably always the result of the process above described—chronic inflammation of the prostate—and it is always present in cases of so-called hypertrophy; the local hypertrophies may result from this inflammatory condition or may rank with tumor-formations in general. They are found in a large percentage in the cases of enlarged prostate, though their presence cannot usually be recognized until the bladder is opened, because they grow into the vesical cavity and cause no change in the rectal surface of the gland, which alone is accessible to the examining finger. They may

Fig. 212.
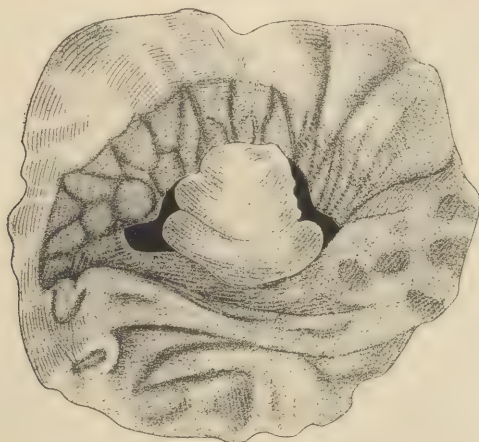
Intravesical enlargement of the prostate (Forgue).

therefore be ignored, except in operative cases; our diagnosis and treatment before operation is that of diffuse enlargement.

Prostatic enlargement is a disease of the *second half of life*, often beginning before the patient becomes fifty years old, but not usually causing him to seek a physician's advice until after that period; indeed, the advanced cases of urinary derangement due to this cause are usually over sixty years of age. The enlargement of the prostate and the development of urinary symptoms are so gradual that the patient is apt to accustom himself to them as to other phenomena of advancing age, and when some pronounced symptom, such as complete retention of urine, leads him to summon medical aid, an advanced stage of the disease is found. Hence surgeons have been accustomed to meet the more advanced cases, and to think of prostatic hypertrophy as a condition of advanced age, while the disease really often begins in middle life, as above stated.

Prostatic enlargement is serious—not directly, but because it inter-

feres with the exit of urine by causing (1) *distortion* of the prostatic urethra, which undergoes elongation, decrease in calibre, sometimes deviation in direction ; (2) *elevation of the level at the vesico-urethral orifice ;* and (3) *obstruction to the return of blood* to the bladder and chronic congestion of this organ.

Following naturally upon the imperfect evacuation of the urine and the chronic congestion of the bladder comes a train of morbid conditions which begin with the bladder and ultimately extend throughout the entire urinary tract.   These are (1) *dilatation of the bladder*, with increase of residual urine ; (2) *fibroid degeneration* of the prostatic sphincter ; (3) *hypertrophy* and degeneration of the *vesical walls* and depressions of mucous membrane (diverticula) between the muscular bands ; (4) *dilatation of ureters and renal pelvis*, with stagnation of urine in them ; (5) congestion and catarrhal inflammation of the entire urinary tract, causing accumulation of its products in the bladder, tending to *calculus-formation ;* (6) *ammoniacal fermentation* of urine, favored by, but not dependent on, the use of unclean catheters ; (7) *septic infection* of the congested urinary tract—"cysto-pyelonephritis" and chronic uræmia ; (8) acute and fatal *uræmia*, provoked by various agencies, particularly the first use of the catheter.

SYMPTOMS.—Among the earliest are difficulty in starting the flow of urine, feebleness of the stream, and undue frequent calls to urinate, especially at night.   During this state the patient often complains more of his digestion than of his urinary organs ; he has loss of appetite, dryness of the mouth, and constipation.

When catarrh of the bladder-neck begins the urinary symptoms become more prominent : the calls to urinate become more frequent, the normal sense of satisfaction is lacking, the urine becomes cloudy and deposits a white sediment.

The incomplete evacuation of the bladder, causing chronic retention of a large quantity—a pint or even a quart—of urine, is apt to be followed by an involuntary escape of this fluid.   This dribbling indicates not " paralysis of the bladder," but over-distention of the organ.

Thus far, the patient may have been fairly comfortable and the nature of his disorder overlooked ; but he is now apt to experience either of two events—a sudden aggravation of the hitherto *mild cystitis* or a complete *retention* of urine. Either may be provoked by prolonged chilling and wetting, especially of the feet, by excessive eating or drinking, or by constipation.   In either of these events the patient usually becomes the subject of chronic cystitis, which exhibits varying degrees of severity, now remaining mild for weeks, again becoming so acute as to confine him to bed.

DIAGNOSIS.—A patient over fifty years of age whose history includes these symptoms should be examined *per rectum*, and undue size of the prostate noticed.   The presence of residual urine is then detected by the passage of a clean soft catheter immediately after the patient has urinated ; a flow of urine (which should be stopped at two ounces) shows that the voluntary evacuation of the bladder is incomplete.

The examiner must now exclude other morbid conditions which may give rise to the symptoms of cystitis, prominent among which are vesical calculus, prostatic cancer, and tuberculosis.   Calculus can generally be recognized by the sound or cystoscope ; cancer of the prostate, by the uneven, nodular hardness of the prostate, the enlargement of inguinal lymph-nodes, emaciation of the patient, and hæma-

turia; tuberculosis, by the nodular thickening in the seminal vesicles and epididymis, as well as in the prostate.

It should be remembered that the chronic retention of urine resulting from prostatic enlargement predisposes to the formation of vesical calculus, which is an exceedingly common—and often overlooked—sequence of this condition.

TREATMENT is general and local. Personal hygiene is very important, including good digestion, regular and easy defecation, warm clothing, air and exercise, avoidance of cold and wet, of excess in eating or alcohol-drinking. The patient should drink three pints or more of pure water daily.

Local treatment endeavors (1) to *reduce the congestion and œdema* of the prostatic region; (2) to *promote the evacuation of the bladder;* and (3) to *prevent or arrest septic infection* of the urinary passages.

(1) For the first object there are three principal means—the milking of the prostate by the finger in the rectum, previously described; the passage of a large sound once a week; and the free use of hot water as baths, rectal enemata, and injections of the bladder. These latter can usually be made without a catheter, because the sphincters in such patients are not firmly contracted; indeed, with a little perseverance the patient can learn to inject his own bladder from the meatus; this is most easily done in the semi-recumbent position. The amount of water should not be large enough to distend the bladder, but it should be hot (100° to 110° F.).

(2) The contractile power of the bladder is greatly stimulated by these injections of hot water, probably because they reduce the œdema and venous congestion. In some cases, however, the patient must be taught to use the catheter.

(3) Septic infection of the bladder, when not arrested by these means, must be combated by injections of silver nitrate (1 : 2000) or of mercury bichloride (1 : 20,000).

Catheters should be Flexible and Clean.—The soft Nélaton catheter (velvet eye preferred) will usually enter the bladder; if it fail, the stiffer coudé instrument of Mercier, commonly called prostatic catheter, generally succeeds. Metallic instruments and those armed with a stylet can easily be made to lacerate the urethra, and are rarely needed except in cases of extreme hypertrophy.

All instruments used should be aseptic. The soft and metal catheters can be sterilized by boiling; elastic instruments should be immersed in 5 per cent. carbolic or similar solution. Catheters in frequent use should be kept in such solution.

It is never amiss to warn the patient that flexible catheters are *prone to disappear* into the urethra; when one is inserted the outer end should be constantly held. He should be also advised to discard a catheter when its surface becomes rough.

It is important that the prostatic urethra as well as the bladder should be irrigated—that is, before the solution is injected the catheter should be withdrawn until the eye has receded one to two inches from the bladder. The fluid then injected washes the prostatic urethra and passes onward into the bladder; the catheter can then be pushed back until the outward flow is re-established. Washing of the bladder should always be made in this way, so as to wash the neck of the bladder—that is, the prostatic urethra.

Internal medication has but little influence in improving the condition of the urine, yet there can be no objection to the proper use of the various demulcents—buchu, corn silk, etc. Salol, boric acid, and turpentine are also recommended, but

as the digestive organs of the prostatic are easily deranged, over-medication must be avoided.

COMPLICATIONS.—These are (1) *complete retention ;* (2) *persistent cystitis* of great severity ; (3) such *distortion or narrowing of the prostatic urethra* as renders catheterism extremely difficult or painful.

Complete retention is a most serious event : when called to such a case the physician should observe three rules of great importance : (1) *never use force* nor lacerate the urethra—in other words, use flexible instruments ; (2) *observe strict aseptic precautions* as to instruments, etc. ; (3) *never empty the bladder completely* at one sitting.

The patient suffering from complete retention should have the rectum emptied by a hot-water injection, to be followed by a suppository containing a quarter grain of morphine. A hot sitz-bath or hot fomentations should be used for twenty or thirty minutes; the patient is then warmly covered in bed, the hips elevated above the shoulders. The anterior urethra is irrigated with hot water and injected with warm clean oil; a clean soft catheter (No. 10 or 12 English) is filled with the oil and introduced, the penis being drawn firmly forward. Steady pressure is often rewarded by a gush of urine; if this effort fail, an elastic prostatic catheter is next tried. If no false passage exist, the prostatic catheter will almost invariably enter the bladder. If, however, the urethra be already lacerated, the difficulties of catheterism are enormously increased. If the softer instrument fail, a metal catheter of long curve and large diameter should next be used; but force must be scrupulously avoided, for no one can know the direction of the distorted and swollen prostatic urethra; forcible and blind catheterism results in false passages, hemorrhage, and a difficult situation.

In rare cases *suprapubic aspiration* must be made, the needle entering at right angles with the spine about an inch above the upper border of the symphysis. A half of the estimated contents of the bladder is withdrawn, hot fomentations again applied, and the patient left in bed for some hours ; the relief of bladder tension and reduction of prostatic œdema thus secured often result in easy catheterism or even voluntary urination. But should retention persist, aspiration must be superseded by one of the methods of operative relief.

Should the physician succeed in introducing the catheter, he must not evacuate the bladder completely at the first sitting ; a third of the estimated quantity—say from six to ten ounces—may be withdrawn, and an ounce or two of some antiseptic solution injected. Some hours later a larger quantity may be withdrawn, and thus in the course of three or four days the bladder may be gradually emptied. Even with the greatest care some fever usually follows complete retention requiring the use of the catheter, yet the illness is kept at a minimum by the measures described.

Persistent cystitis of high grade and difficult catheterism from prostatic distortion must be ultimately relieved by operative treatment.

Operative Treatment.—Surgical aid may be furnished in one of three ways :

(1) *Drainage of the bladder,* either by perineal urethrotomy or suprapubic cystotomy, or a combination of the two. The great improvements in suprapubic cystotomy (see section on " Operations ") render it the preferable method.

Drainage of the bladder may be *temporary* or *permanent.* In many cases of comparatively recent origin the cystitis and inflammatory swelling entirely subside in two or three weeks, after which the tube may be removed and the wounds permitted to heal ; the patient may then enjoy years of freedom from urinary discom-

fort. In other cases, where the patient has long been unable to urinate without a catheter, the former troubles are apt soon to return; in such cases it was formerly the custom to make the artificial opening permanent by having the patient wear a rubber or silver tube in the suprapubic opening, removing it daily for cleansing. In more recent times, however, the permanent fistula has fallen into disfavor, having been supplanted by the following operations.

(2) *Prostatectomy*, by which is meant the removal of projecting portions of the prostate through the suprapubic wound and the restoration of a low level channel from bladder to urethra. The prostatic tumors, when pedicled, are removed by scissors, snare, or cautery; when imbedded in the prostate they are enucleated, the mucous membrane covering them being first freely incised, and an assistant's finger in the rectum pressing the prostate firmly against the operator's finger in the bladder. In this way large masses of hypertrophied prostatic tissue are easily enucleated. The hemorrhage is usually slight, and is controlled by hot water and packing with iodoform gauze. In every case of prostatectomy perineal urethrotomy should be made and the prostate thoroughly stretched; any bar at the vesico-urethral orifice should be freely incised.

(3) *Castration.*—The work of Ramm and White has led to the attempt to relieve sufferers from prostatic hypertrophy by the removal of both testicles, the plan having been suggested by the frequent atrophy of uterine fibroids after the removal of both ovaries. As prostatic sufferers are frequently in advanced life, they sometimes consent to this mutilation in the hope of securing relief from the agonies of severe cystitis and difficult catheterism. In a large percentage of the cases already reported more or less complete relief from cystitis has been secured, and in some the power of voluntary urination is said to have returned; in a smaller number more or less complete failure to secure any benefit whatever was the result. In some instances double castration has been performed and recommended in cases where an undiscovered stone was subsequently found to be the cause of the trouble; for it is sometimes impossible to detect by the sound a calculus hidden in a pocket of the bladder.

It is evident that this operation should be performed only after two premises have been established: first, that the patient's cystitis is not due to vesical calculus, tumor, or any condition other than prostatic enlargement; and second, that the prospect of relief by simple temporary drainage of the bladder is not good. In other words, double castration should not be made until the bladder has been opened and explored by the finger.

Ligature of the vas deferens on each side has been found in the few cases already tried to succeed as well as double castration. Since it is a slight operation, free from the objections—surgical and æsthetic—which may be urged against double castration, it should be substituted for the latter as a purely tentative procedure.

To summarize: when surgical interference becomes necessary the best treatment is *temporary drainage of the bladder with stretching of the prostatic urethra.* If this exploration reveals such great distortion and overgrowth of the prostate as renders the cure by simple drainage doubtful, the surgeon must be prepared to make either a *prostatectomy*, a *ligation of both vasa deferens*, or a *double castration.*

Tuberculosis of the prostate and appendages is a very frequent though often overlooked cause of the symptoms of cystitis; it is espe-

cially common between the ages of fifteen and thirty-five, and may occurs in otherwise healthy, robust subjects.

The SYMPTOMS are those found in cystitis from other causes—frequency and pain in urination, as marked by night as by day, with pus and occasionally blood in the urine. Sometimes a slight muco-purulent discharge and swelling of the meatus give rise to a suspicion of gonorrhœal infection.

The DIAGNOSIS can be established by digital examination of the epididymis and of the prostate and seminal vesicles, in each of which (at least on one side) nodular thickenings are found. The discovery of tubercle bacilli in the urinary pus makes the diagnosis absolute. There is commonly a slight elevation of temperature.

The TREATMENT is medical and surgical. Operative measures should be limited to the evacuation of softened tuberculous foci; attempts at radical cure are futile both in theory and in practice. Medicinal treatment includes hygiene, dry air, sunshine, good food, and guaiacol: the drug should be given internally in doses of five, gradually increased to fifteen drops four times daily, in cream, milk, or wine, and it should be applied locally to the perineum, suprapubic space, and epididymis. To avoid irritation of the skin the guaiacol may be mixed with an equal volume of sweet oil or glycerin.

Tumors of the prostate are *papilloma, cyst,* and *cancer. Papillomata* of the prostate have been occasionally detected and removed through the endoscope or by perineal urethrotomy. *Cysts* are commonly either dilatations of the prostatic utricle from occlusion of its orifice (as in new-born infants) or distended prostatic glands. Neither of these varieties is sufficiently common to require discussion.

Cancer of the prostate—including carcinoma and sarcoma—is a not infrequent disease, occurring chiefly in patients under ten and over fifty years of age. About seven-eighths of the tumors are found on histological examination to be carcinoma, the remainder, sarcoma; the clinical distinction is often impossible and usually unimportant.

Cancer of the prostate arises by extension from adjacent organs (rectum, bladder), by metastasis from cancer of a distant organ, and as a primary tumor.

The SYMPTOMS of primary prostatic cancer are *hæmaturia, pain,* and *cystitis.* The bleeding occurs without apparent provocation, and may for months be rarely seen; in the later stages the hemorrhage often becomes profuse. Pain is felt in the perineum, rectum, and down the thighs, and is often increased by urination. Cystitis may not occur until the cancerous surface ulcerates.

No one of these symptoms is invariably present.

The DIAGNOSIS of cancer of the prostate is sometimes difficult and often neglected, because of the more frequent occurrence of the ordinary hypertrophy of the organ.

Three of the most important and constant diagnostic signs are—(1) progressive emaciation and pallor; (2) hard enlargement of lymph-nodes in the groins, within the pelvis, and in Scarpa's triangle; (3) irregular nodular enlargement of the prostate. The discovery of recognizable cancer-tissue in the urine or the inspection of a malignant ulcer through the cystoscope is conclusive evidence. Prostatic cancer may be grafted upon senile hypertrophy, from which it must be carefully distinguished.

In children the fatal termination is reached in a few months; in elderly men the disease progresses less rapidly, lasting from one to five years.

The TREATMENT of prostatic cancer can be only palliative; for although the cancerous prostate has been extirpated ten times, yet the patients who survived the operation have all died of recurrence within a few months. The pain must be mitigated by morphine; cystitis and urinary retention require the treatment outlined for prostatic hypertrophy; and when other measures fail to relieve the vesical distress, a permanent suprapubic exit for the urine must be made.

DISEASES OF THE BLADDER.

CYSTITIS.

Cystitis is a *bacterial infection of the bladder:* the pyogenic bacteria (especially the colon bacillus), the tubercle bacillus, and the gonococcus are the species most frequently concerned.

Pyogenic bacteria are incapable of infecting a normal bladder: this has been amply proven by experiment, and is illustrated in the fact that unclean catheters and sounds are often introduced without causing cystitis.

When, however, the nutrition of the bladder is impaired or its circulation seriously disturbed, as by a calculus, a tight urethral stricture, or prostatic enlargement, then the pus-microbes are found growing in its walls and producing the inflammatory reaction that we call cystitis. These bacteria always have easy access to the bladder even when no instruments are used, for they may reach it

FIG. 213.
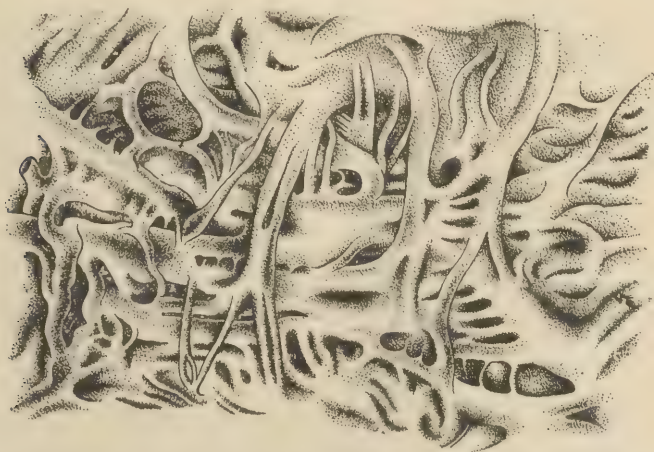
Internal appearance of bladder in some cases of inveterate cystitis; mucosa sacculated by columns of hypertrophied tissue (Launois).

through the circulation, by extension from the urethra, or by penetration from the rectum. It has been shown that if the evacuation of a dog's bladder be prevented by ligation of the urethra, and a slight abrasion of his anterior rectal wall be made, cystitis promptly occurs. The urine contains various pus-bacteria, most frequently the colon bacillus, which has invaded first the recto-vesical tissue and then the bladder-wall.

The important practical fact is, therefore, that cystitis (when neither tuberculous nor gonorrhœal) is always a secondary, not a primary, morbid condition: we should begin our treatment of a case of cystitis by searching for the pre-existent cause and removing it when possible.

The classical SYMPTOMS of cystitis are three: *frequency of micturition, pain* in urination, and *pus in the urine.* Yet the frequency and pain in urination are really caused by an irritation of the prostatic urethra rather than of the bladder. Hence when these symptoms are present they indicate *prostato-cystitis* rather than a cystitis proper; and in practice when we speak of cystitis we mean that the neck of the bladder (prostatic urethra), as well as the bladder-cavity, is inflamed—a prostato-cystitis. It is also important to remember that these symptoms may also be caused by an inflammation in the vicinity of the bladder, but outside of its cavity—of the seminal vesicle or of the lower end of the ureter. Infection doubtless usually spreads from these to the bladder, so that a secondary cystitis does really exist.

The TREATMENT of prostato-cystitis endeavors first to discover the antecedent morbid condition, and second to recognize the variety of bacterial infection. As already stated, cystitis is secondary to some pre-existing lesion; the commonest of these are gonorrhœa, a tight stricture of the deep urethra, prostatic enlargement, stone or tumor in the bladder, tuberculosis of the genital organs, and rectal abscess. Since these respective conditions require widely different treatment, it is evident that there is no treatment applicable to cystitis in general: we must treat first the cause, by the removal of which we usually cure the cystitis—stretching a stricture, removing a vesical calculus, etc.

It is true that we can often diminish the patient's sufferings, even without removing the cause, by administering internal demulcents, such as santal oil, buchu, and alkalies, and by washing the deep urethra and bladder with hot water containing a little borax or boric acid. But such treatment should be employed only to palliate the patient's distress, while we dilate his stricture or treat any other lesion which may be causing the cystitis: to rely upon internal treatment or washing of the bladder for the cure of cystitis is irrational and futile. In a small percentage of cases of cystitis—which have become less numerous as our means for accurate diagnosis have improved—the most careful examination fails to reveal a local cause. In these cases we have to assume a constitutional cause for the local impairment of nutrition which makes cystitis possible—such as gout, lithiasis, etc.—and to treat the patient for these conditions.

The surgeon should therefore never treat a cystitis without first examining carefully the entire urinary and genital tract and the rectum for local lesions; and he should remember the great frequency of tuberculosis of these organs as a cause of cystitis, especially in young men.

STONE.

Calculus is one of the common diseases of the bladder and a frequent cause of cystitis. A vesical stone consists chiefly of the normal urinary salts—phosphates, urates, oxalates—deposited upon a nucleus. In many cases this nucleus is a foreign body; in many others it is an aggregation of crystals imbedded in an albuminous substance. The greatest diversity of objects have been found enclosed in bladder-stones, such as a bullet, fragment of bone, piece of a catheter, of lead-pencil, straw, chewing-gum, hair-pin, blood-clot, fragment of necrotic tissue, clumps of pus, drops of oil. Some of these objects have been used

in irritating the urethra, and have slipped or been forced into the bladder.

Before a calculus has attained much size it may be carried through the urethra with the flow of urine, or may become lodged in this channel, causing partial or complete retention of urine. After the constant deposit of urinary salts upon it has rendered its size too great for such passage the calculus can be removed only by surgical means: all attempts to dissolve it, either by internal medication or by local injections into the bladder, are futile.

Conditions which favor calculus-formation are, possibly, *the drinking of hard water and eating of albuminous foods in excess;* but certainly a *frequent predisposing cause is chronic retention of urine,* particularly when accompanied by alkaline fermentation of the retained urine: as these conditions frequently exist as the sequel of prostatic enlargement, calculi are found with great frequency in the subjects of this disease.

This is a most important clinical fact, because either of these conditions produces severe cystitis, and the detection of one may cause the surgeon to forget to examine for the other. Thus many subjects of prostatic enlargement are permitted to carry in their bladders undetected stones because all the symptoms are assumed to be due to the prostatic disease. Moreover, the difficulty of detecting a calculus is much increased by the prostatic enlargement and the pockets in the mucous membrane so common in such cases.

SYMPTOMS.—The symptoms caused by a vesical calculus vary greatly in severity according to the size, mobility, roughness, and location of the stone. A small stone encysted in a pocket away from the bladder-neck may cause but little distress, while a calculus which is rasped against the sensitive bladder-neck occasions severe pain.

The symptoms are in general those of *cystitis*—unduly frequent and painful urination, with pus, sometimes blood, in the urine: *pain felt in the perineum, rectum, and along the urethra, especially the glans penis, is usual.* The pain and frequency in urination are commonly increased by active bodily movement, riding in wagons, etc., and diminish during rest in bed. Sometimes reflex pains in other parts of the body—the sole of the foot, instep, chest, or arm—have been known to disappear upon the removal of a vesical calculus. Particles of gravel may be brought away with the urine.

DIAGNOSIS.—Stone in the bladder must be distinguished from other causes of cystitis, of which *prostatic enlargement, tight stricture, tuberculosis of the bladder-neck,* and *vesical tumor* are the most common. A calculus may coexist with any of these, and is very common with long-standing cystitis from prostatic hypertrophy; tuberculous ulcers and tumors of the bladder are often plastered over with phosphates, which may attain the size and dignity of a calculus.

In every case in which the symptoms suggest a vesical calculus, even though one of the other conditions (excluding tuberculosis) is present, an examination of the bladder should be made. The means employed are—(1) the *stone-searcher* or short-beaked sound; (2) the *cystoscope;* and (3) *digital exploration* through a suprapubic incision.

In the majority of cases a stone in the bladder can be detected by the short-beaked sound of small calibre (15 to 20 French). Before using this instrument the bladder should be irrigated with clean water, about five ounces of which are finally allowed to remain in its cavity. The patient lies horizontally with his hips somewhat elevated; the well-lubricated instrument is gently introduced, and the beak made to touch every part of the vesical wall. In a certain number of cases

a calculus escapes detection for one of the following reasons: (1) the sound may not enter the bladder, its point remaining in the prostatic urethra; (2) the pain may be so great that the bladder contracts, forcing out the water necessary to distend it; (3) the stone may be so enveloped by a soft covering—the mucous membrane (so-called pocketed or encysted stone), pus, or blood—that the sound fails to touch the calculus; (4) in cases of enlarged prostate, when portions of this gland project into the bladder, a stone may be so situated, above or below these projecting masses, that the beak of the instrument cannot by any manipulation be brought into contact with it. Some of these difficulties are decreased by anæsthesia, which indeed permits a more thorough examination; even then, however, the third and fourth of the above conditions may prevent the detection of the stone.

The *cystoscope* has repeatedly discovered vesical calculi which the sound had failed to reach, even with the aid of anæsthesia. When this instrument is not available it is generally wiser to advise a digital exploration than to assert the absence of a stone when symptoms of severe chronic cystitis cannot be explained by the existence of other causes.

TREATMENT.—The detection of a vesical calculus is a demand for immediate operative treatment: efforts at dissolving the stone are a waste of valuable time.

The surgeon has a choice of two operative measures: (1) *crushing of the stone in the bladder* and removal of the fragments by irrigation—*lithotrity;* and (2) *removal of the calculus entire* through an incision—*lithotomy.* The crushing operation is now usually done at one sitting, and is then termed *litholapaxy;* and the incision for the removal of the entire stone may divide the membranous urethra (*median lithotomy*), the prostate and perineum (*lateral lithotomy*), or the prevesical tissues (*suprapubic lithotomy*). The choice among these four operations must be determined by the conditions existing in each case; their relative advantages are as follows:

Litholapaxy has only one point of superiority over the others, though this is sometimes important—namely, its freedom from cutting; this advantage is appreciated by the patient rather than by the surgeon. The danger of septic infection from the cutting operations is now much less than formerly, and is not entirely absent from litholapaxy.

Median lithotomy affords a rapid and safe removal for small stones; it is not adapted to larger ones nor to cases where the prostate is enlarged.

Lateral lithotomy was until 1880 the usual cutting operation, since it permitted the extraction of large stones without regard to the size of the prostate. In the last fifteen years, however, it has fallen into disuse, having been replaced by

Suprapubic lithotomy, which affords perfect access to the bladder and extraction of large stones without any damage to the sensitive bladder-neck.

The *disadvantages of litholapaxy* are three: (1) the length of time, and hence of anæsthesia, required; (2) the impossibility of grasping and crushing a stone which is encysted or ensconced behind a prostatic enlargement or one which is very hard; and (3) the chance that a minute fragment may remain in the bladder and thus form a nucleus for a new stone.

The *disadvantages of the cutting operations,* on the other hand, are the patient's natural repugnance to the knife and the greater chance of septic infection. While the latter still exists in cases where the urine

is foul, yet the mortality from it has been much reduced by the combination of suprapubic cystotomy with perineal drainage.

Surgeons differ in their choice of stone operations according to their estimate of these relative features, as well as according to their experience with the various methods. They are generally agreed upon the following :

(1) The *suprapubic operation* should be made when either the stone or the prostate is very large, the kidneys impaired, or the subject under twelve years of age ; (2) in cases of small calculi, normal prostate, and healthy kidneys the surgeon chooses *litholapaxy, median* or *suprapubic lithotomy*, according to his own judgment of the case. Hence the suprapubic operation is decidedly the most frequently performed. In *boys before puberty* the urethra is small and the bladder high in the pelvis, making the *suprapubic operation preferable*, although some surgeons still advocate litholapaxy or lateral lithotomy for these cases.

The cutting operations which are made for purposes other than the extraction of stone are described in the section on "Operations," p. 511.

Litholapaxy is thus performed : If the stone be small, it may be removed without great pain and without general anæsthesia : four ounces of cocaine solution, one grain to the ounce, injected into the bladder, may suffice for the mitigation of suffering. Otherwise the patient is thoroughly anæsthetized. The rectum having been emptied, the bladder, which should have been cleansed for several days previously, is again thoroughly irrigated with borax-water, four to six ounces of which are finally permitted to remain ; a rubber tube may be tied lightly around the penis just behind the glans to prevent the escape of water. The urethra is filled with oil or liquid vaseline and the lithotrite introduced. Its shaft is held at an angle of forty-five degrees with the table, its beak then making a depression in the floor of the bladder, into which the stone may roll ; the male blade is then withdrawn an inch or more with the hope of catching the stone in the jaws of the instrument. If the stone be felt, the instrument is locked and the male blade screwed home ; then the opening and closing of the blades are repeated until no large fragment can be detected.

The actual process is, however, rarely so simple : there may be considerable difficulty in catching the stone in the beak, which must often be turned from side to side and carried into different parts of the bladder before the calculus can be distinctly caught between the blades ; and the same fishing process may have to be repeated with the larger fragments resulting from the first crushing. Sometimes the catching of the stone is facilitated by changing the position of the patient, especially by the elevation of the hips. It is very important, especially for one inexperienced in the operation, to remember *never to close the blades except when the beak is in the upright position ;* otherwise the bladder-wall may be lacerated. The crushing should be done as completely as possible before the instrument is withdrawn.

The lithotrite is then removed and the large tube of the evacuator inserted. When its point has entered the bladder the communication between tube and bulb filled with water is opened, the water in the bladder driving the air out of the tube into the bulb. The pumping process is then begun and continued until no further clicking of fragments against the tube can be detected. After withdrawal of the evacuator the urethra is thoroughly irrigated.

Some cystitis follows so much instrumentation; it must be treated by irrigation, suppositories, etc., and after its subsidence the bladder should be again washed through the evacuator.

Various complications occur during and after litholapaxy, such as hemorrhage, clogging of the blades of the lithotrite with débris, clogging of the evacuating tube, and breaking of the lithotrite (which should always be tested on a brick before the operation); any of which may test the surgeon's judgment and ingenuity.

Tumors of the Bladder.—The use of the cystoscope and the practice of digital exploration of the bladder, both of which measures have been employed only since 1881, have shown that bladder-tumors, formerly considered rare, are by no means infrequent. They are found oftener in *males* than in females, and usually after the age of thirty years. Although many varieties of histological structure have been

Fig. 214.
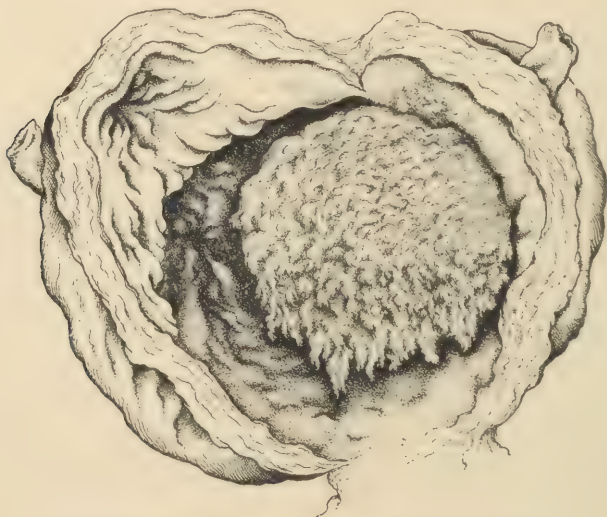
Villous tumor (papilloma) of bladder (Musée Dupuytren).

observed, we may for practical purposes specify three classes : *papilloma*, *fibroma* (both benignant), and *cancer* (malignant).

SYMPTOMS.—*Bladder-tumors usually give rise to three symptoms—hemorrhage, pain,* and *cystitis.* Hemorrhage occurs from nearly all bladder-tumors at some stage of their growth. It is often distinguished from the hemorrhage due to calculus by three features : (1) its occurrence independently of exercise, as it often happens during sleep ; (2) its abundance, the bladder perhaps filling with clots ; and (3) its increasing frequency.

Pain due to the growth itself is caused more frequently and earlier by malignant than by benignant growths, and by tumors near the bladder-neck than by those more remotely situated ; it is felt in the urethra, glans penis, rectum, and thighs. Such pain is of course to be distinguished from that due to the bladder inflammation.

Cystitis is a common, though often a late, result of a bladder-tumor.

The DIAGNOSIS seeks to establish first the existence of a vesical growth, and then its degree of malignancy.

The SYMPTOMS caused by either variety are not always sufficient in the early stages to distinguish it from certain other morbid conditions, particularly tuberculosis and stone; although the sound and the examination of the sediment for tubercle bacilli afford a probable means for excluding these. Digital examination per rectum and bimanual palpation when the bladder is nearly empty sometimes disclose an unnatural hardness, thickening, and lack of symmetry of the prostate and recto-vesical tissues.

FIG. 215.

Tumor of bladder as seen with cystoscope (Nitze).

There are but *two positive proofs* of the existence of vesical tumor—*the discovery in the urine of fragments of the growth,* and *ocular detection by the cystoscope.*

The determination of the malignancy of the growth is sometimes easy, at other times difficult or impossible. A bladder-tumor in a young person, causing much hemorrhage and no pain, is generally a benignant papilloma; a tumor in an old person, causing constant, severe, and radiating pains, is usually malignant. Between these two extremes are many cases in which the degree of malignancy can be only conjectured, even when fragments are found in the urine or caught (as they may sometimes be) in the eye of a catheter.

Cystoscopic Examination.—In every case of suspected bladder-tumor

FIG. 216.

Illumination of anterior vesical wall by Nitze's cystoscope.

—indeed in every case of obscure bladder disease—the interior of the organ should be inspected through the cystoscope.

Tumors will usually be found at or near the trigone, at least 80 per cent. occupying this portion of the bladder. Papillomata can be easily recognized as slender, warty growths, similar to the pointed condylomata of the external genitals;

fibromata are less easily distinguished from the folds of mucous membrane. Cancerous growths are usually sessile tumors, whose surfaces, however, may be ragged, ulcerated, or papillomatous; this latter feature has led to much confusion of the malignant with the benignant papillomata. The distinction exists in the base rather than in the surface of the growth; the color of the surface is, however, important, the benignant tumors being pink and the malignant gray.

A transformation from benignancy to malignancy certainly occurs sometimes in these bladder-tumors; operative removal, if incomplete, seems to hasten this transformation.

TREATMENT.—This is *palliative* and *radical*. The arrest of hemorrhage is often accomplished by the internal administration of turpentine oil, three to ten drops on sugar or in emulsion three to five times daily; clots can be removed from the bladder by washing, through a catheter, with warm water, to which a little pepsin or papain may be profitably added. Pain is of course to be controlled by morphine subcutaneously or by rectal suppository. In cases of inoperable malignant growth pain and cystitis may become so severe as to require the institution of a permanent suprapubic fistula for the exit of urine.

Radical operation means the excision of the tumor, which should always be undertaken through a suprapubic incision. The results of such excision have been very favorable for benignant, but unsatisfactory for malignant, growths, for in the latter class the anatomical relations render the complete removal of the base of the growth difficult, often impossible. Extirpation of a vesical cancer often requires resection of the bladder-wall, and has even then been followed by early recurrence.

In general it may be stated that vesical growths which have infiltrated the bladder-wall, as revealed by the finger in the rectum or after incision in the bladder, are not suitable for radical operation; those, on the other hand, whose bases are normal tissue, can be removed with a fair prospect of perfect recovery, or at least a long period of freedom from recurrence.

Tuberculosis.—Primary tuberculosis of the bladder is very rare; in nearly all cases the infection has spread to this organ from the prostate or the kidneys. Its consideration is therefore included in the account of prostatic and renal tuberculosis. The discovery by the cystoscope of shallow ulcers, and by the microscope of tubercle bacilli in the urinary pus, is the requirement of diagnosis. In one case seen by the writer the most prominent clinical feature was the frequent passage of phosphatic sand; the cystoscope revealed two ulcers coated with phosphates.

PERICYSTITIS; PELVIC INFLAMMATION AND ABSCESS.

The connective tissue of the male pelvis is not infrequently the seat of inflammation and suppuration, the results of extension of a septic infection from the various pelvic organs. This connective tissue consists anatomically and clinically of three portions: (1) *that which encloses the rectum;* (2) the *broad ligament* (enclosing the seminal vesicles, ampullæ, and utricle); and (3) the *perivesical tissue.* The infections and inflammations are found clinically to correspond to this anatomical division.

Infection of the connective tissue constituting the broad ligament is an extension from septic processes in the seminal tubes and prostate; its symptoms are therefore those exhibited by inflammation of the prostate

and appendages. When suppuration occurs the pus may break through the broad ligament in any direction—the peritoneum, rectum, perineum, or bladder: such disastrous burrowing of pus should be prevented by prompt incision of the abscess either from the perineum or (rarely) from the rectum.

Infection of the pelvic connective tissue in front of the broad ligament, including the *suprapubic space* or *cavity of Retzius*, commonly results from extension of an inflammation from the bladder; it is especially common in the prevesical space. Less frequently suppuration in this space results from the burrowing of pus from a distant abscess, such as an appendicitis. The usual symptoms of suppuration and cystitis, with a hard swelling above the symphysis, mark this condition and should suggest an incision into the prevesical space.

DISEASES OF THE KIDNEY, PELVIS, AND URETER.

Infections.—The upper urinary passages are subject to three bacterial invasions: *gonorrhœal, septic,* and *tuberculous.*

Gonorrhœa occasionally extends from the bladder into and through the ureter to the kidney-pelvis and renal tubules, making a gonorrhœal pyelo-nephritis. Such invasion is marked by the occurrence of chills, fever, pain, and tenderness extending from the kidney along the course of the ureter to the corresponding testicles, and by pyuria. With the cystoscope pus may be seen issuing from the ureteral orifice.

TREATMENT.—In the female, where the ureter can be catheterized, irrigation of this canal and the kidney pelvis with hot water containing hydrastin muriate (saturated solution) or potassium permanganate (1 : 3000) can be made; in the male such local treatment is as yet impracticable.

In both sexes guaiacol (twenty minims mixed with an equal volume of olive oil or glycerin) should be rubbed into the skin of the loin and abdomen over the kidney and ureter twice daily, and santal oil, boric acid, or salol given internally. In a few recorded cases the gonorrhœal infection has caused abscesses in the renal tissues; and in one such case (Weir) nephrectomy was successfully performed.

Septic Infection : Pyelitis, Pyelo-nephritis, Surgical Kidney.—These various forms of septic infection are frequent sequels of chronic septic infection of the bladder (chronic cystitis), especially in cases where there exists a chronic obstruction to the exit of urine, such as prostatic enlargement, vesical calculus, and tight stricture of the deep urethra : in such cases first the ureter and then the pelves become distended with urine. Septic infection of the upper urinary tract may be provoked by catheterism in the puerperal state, doubtless through infection of the bladder. In all cases of long-standing cystitis, especially in elderly men, the possibility of this condition must be investigated, since treatment and prognosis are determined largely by its presence or absence.

When acute, septic invasion of the upper urinary passages is marked by chills, fever, pain over the kidney, along the course of the ureter, down the thigh, and in the corresponding testicle, which may be retracted ; it is, however, more frequently chronic, and is then a gradual and insidious process, whose symptoms are usually masked by the more pronounced signs of the coexistent cystitis.

In a few cases an acute septic infection of the kidney and its pelvis occurs from the blood-current, and not by extension from the bladder; it is then a complication of general infections, such as typhoid fever, osteomyelitis, diphtheria, etc. Suppurative pyelitis also follows the formation of a renal calculus.

TREATMENT.—Internal medication, by salol or other antiseptic, is usually fruitless; the local application of guaiacol, and in the female the irrigation of the renal pelvis, as described in the preceding section, should be tried.

FIG. 217.

Double uretero-pyelo-nephritis, with portion of greatly thickened bladder-wall. Ureters dilated and shortened. Kidneys showing changes characteristic of pyelo-nephritis (Musée Guyon).

Rational treatment consists in arresting the cystitis of which the pyelitis is the extension: this may be accomplished by the careful dilatation of the urethral stricture, the removal of the vesical calculus, tumor, etc. In cases of severe cystitis and pyelitis from prostatic enlargement, simple drainage of the bladder for a few weeks has been followed by a cessation of the inflammation in the upper urinary channels. In cases where the septic infection has invaded the kidney structure with the production of multiple abscesses—the so-called "surgical kidney"—cure has not often been obtained, and then only by incision and drainage of the kidney (nephrotomy) or by the removal of the organ.

Pyonephrosis.—This term designates an accumulation of *pus distending the renal pelvis* and sooner or later destroying the kidney substance. It is caused by a *combination of septic infection with an obstruction* to the escape of urine from the ureter, this duct being occluded by a calculus, stricture, fragment of tissue, tumor in the bladder, or uterine tumor compressing the lower end of the ureter, etc.

Pelvis and kidney are converted into a pus-sac; the occlusion of the ureter may entirely prevent the escape of this pus into the bladder, so that the urine (from the opposite kidney) may be clear and normal. Sometimes the occlusion is intermittent, in which case pus escapes into the bladder and mingles with the urine for some days, and is then shut off for a similar period. The pus-sac may be so large as to be distinctly

Fig. 218.
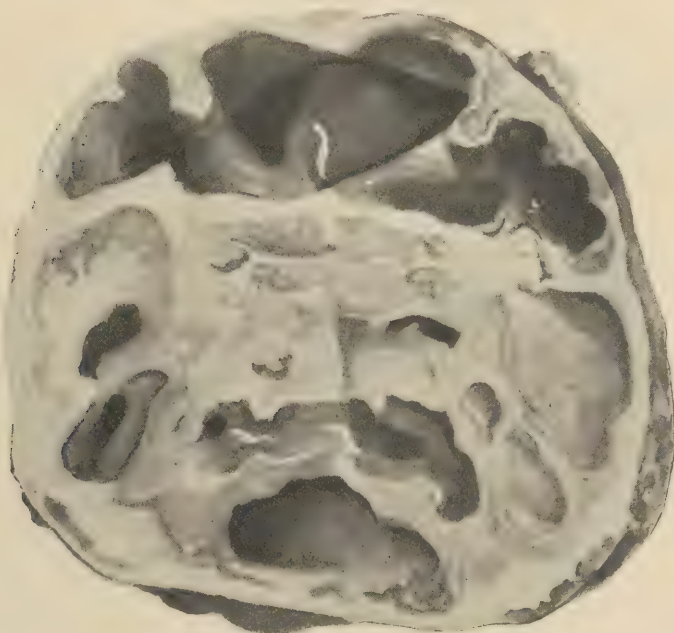
Hydro-pyonephrosis (Richardson).

perceptible as a tumor in the renal region. Spontaneous recovery, though rare, has been known to occur by the escape of the contents through the ureter into the bladder, or by ulceration and discharge into the intestine or the lung.

TREATMENT.—The diagnosis having been established by aspiration of the tumor, a *nephrotomy* should be made. If a renal calculus be found, its removal will be the only measure necessary; if no apparent cause for the pyonephrosis be detected or tuberculosis be discovered, the advisability of immediate nephrectomy may be considered. The best practice is, however, simply to drain, not immediately to excise the kidney; for drainage is often followed by complete recovery, and if a fistula persists, nephrectomy can be made later with less danger of a fatal result. In a few cases simple aspiration of a pyonephrosis has been followed by recovery.

Tuberculosis of the kidney may occur at any time of life, though most frequent in youth. It may occasion no symptoms beyond an admixture of pus and a little blood with the urine, some tenderness over the kidney, frequent urination, and a slight but constant increase of body temperature. When clots of pus or tissue-fragments occlude the ureter, however, then renal colic and pain in the testicle are felt. The infection is apt to spread to the bladder, after which the symptoms of severe cystitis supervene.

When tubercle bacilli are discovered in the urinary pus the diagnosis is positive; it is probable when the renal symptoms just mentioned are associated with tuberculous infection of epididymis and prostate, of lungs, joints, and other tissues.

FIG. 219.

Tuberculosis of kidney: multiple abscesses and degenerations (Richardson).

Otherwise renal tuberculosis can be only suspected, and can be distinguished from other causes of pyelitis only when the kidney is exposed to view through an incision.

TREATMENT.—Many cases of complete recovery after removal of the infected kidney have been recorded; in many others such removal has been followed by death from uræmia, the autopsy disclosing extensive though unsuspected tuberculosis of the opposite kidney and of other organs. The impossibility of proving before operation that the tuberculosis is limited to the suspected kidney has caused a diversity of opinion among surgeons as to what course is best; probably a nephrotomy, thorough curetting of the diseased tissues, followed by the hygienic and medicinal treatment for tuberculosis in general—guaiacol, a dry sunny climate, etc.—are safest and best.

CALCULUS.

Stones are found in the kidney at all ages and in both sexes, the majority of cases being in the second half of life and in males. They

are usually composed of *uric acid, urates,* or *oxalates;* more rarely of phosphates, cystin, or xanthin.

The CAUSES of the calculus-formation are generally constitutional, such as the gouty condition, though a foreign body, such as a clump of pus, of mucus, blood-clot, or fragment of tissue, is commonly found as the nucleus on which the urinary salts have been precipitated. Calculi found in the living subject vary in size from minute aggregations of crystals to stones weighing over two ounces, and in numbers up to hundreds; the severity of the symptoms bears no relation to the size of the stone, since small sharp concretions may cause the most acute distress.

SYMPTOMS.—These vary extremely in degree from distracting suffering to almost nothing. Three symptoms are commonly present—*pain, pyuria,* and *hœmaturia;* and several others are frequent—disorders of micturition, nausea, and vomiting.

Pain is felt in the renal region, along the ureter, in the testicle, and down the thigh; sometimes also in the opposite kidney; it is commonly *intermittent.* At intervals the pain is apt to be aggravated into a series of agonizing paroxysms called *renal colic,* so severe that nothing but chloroform can mitigate the suffering. Renal colic is due to spasmodic contractions of the pelvis and ureter; sometimes it is provoked by the passage of a small calculus into and down the ureter, and ceases abruptly when the stone enters the bladder; but it may occur when the ureter is clear, and seems then to be provoked by the irritation of a stone in the pelvis.

Pyuria is an almost constant symptom of renal calculus, the pus being derived from the inflamed pelvis and ureter.

Hœmaturia is not observed in every case, and is generally intermittent, being provoked by exercise or jolting in a vehicle.

Frequency of urination with some pain is not rare, and should be remembered as a feature of renal irritation, because when associated with pus in the urine the symptoms are often erroneously ascribed to a cystitis.

Nausea and vomiting are occasional features in the course of renal calculus; they are almost constant during renal colic.

DIAGNOSIS.—In cases presenting all the symptoms just described the diagnosis is simple; but since in many cases some of these symptoms—indeed almost all except pyuria—may be absent, the differentiation between renal calculus and pyelitis due to other causes, especially tuberculosis, is difficult.

In every case of pyelitis the surgeon should make a microscopic examination of the urine, noting pus, blood, crystals, and bacteria; the epithelium present is of no particular value in differential diagnosis. Then with the cystoscope it can be seen from which ureter the pus issues, and from the conspectus of symptoms a diagnosis of greater or less certainty is made. It must be said that after most careful and thorough examination competent surgeons have opened the kidney in the full expectation of finding a calculus, but with negative result, though in several of these cases the drainage has resulted in a cure of the pyelitis. In some cases only minute concretions, as large as pin-heads, have been found, but their removal has effected a cure. Hence a strong probability of renal stone warrants an exploratory incision if the general condition be favorable. Possibly the new rays called by Röntgen's name may ultimately be of service in making a positive diagnosis of renal calculus by the photographic or phosphorescent plate.

TREATMENT.—In every case of suspected renal calculus medicinal treatment may be tried, not with the hope of dissolving a stone of considerable size, but for the purpose of mechanically washing down into the bladder small concretions; for, as already stated, the small, even minute concretions sometimes cause the severest symptoms, even when no appreciable calculus is present.

Medicinal treatment consists of restriction of the albuminous and saccharine articles of diet to a minimum, avoidance of constipation, and the free ingestion of pure water containing alkalies; whether the solution be natural or artificial is probably immaterial. The popular belief that lithia compounds and spring waters containing them have an especially good effect is hardly warranted by clinical experience; the same remark applies to the various remedies sold as solvents, such as piperazine. The nitrates and acetates of sodium and potassium—one to two drachms daily, dissolved in two quarts or more of water—may be substituted for the natural alkaline waters, such as Carlsbad or Vichy. In case of persistent nausea, flushing of the kidney can be easily secured by injection of the water into the lower bowel.

Such treatment has repeatedly caused the expulsion of small stones and a restoration of the normal condition of the kidney pelvis and ureter. Yet it usually fails, in which case *surgical means* must be considered. This consists in an incision down to the kidney, a careful digital examination of the organ, its pelvis and the upper part of the ureter; and if a stone be detected (or even otherwise in the judgment of the surgeon) an incision through its substance. If no calculus be touched by the finger-tip passed into the kidney pelvis, a long probe (uterine or other), bent into the shape of a very short-beaked sound, may be used to explore the calyces of the kidney; and a flexible probe should be passed down the ureter to the bladder, since a stone lodged in the lower segment of the ureter may give all the symptoms of renal calculus.

Some surgeons recommend, after exposing the kidney, the exploration of its tissue and pelvis by repeated punctures with a needle, a negative result causing them to refrain from incising the kidney itself. Such exploration should, however, never prevent the incision and digital exploration of the pelvis.

In some cases the kidney tissue is found practically destroyed by the pressure-atrophy and suppuration consequent upon the stone-formation; yet after drainage complete healing will commonly occur, so that the more dangerous operation of nephrectomy, as practised by some under these circumstances, is to be avoided.

TUMORS.

Enlargements of the kidney and its pelvis are of three kinds: (1) *distention* with retained urine or pus; (2) *cysts;* (3) *neoplasms*. The first class includes pyonephrosis (already described) and

Hydronephrosis.—This term designates a chronic distention of the kidney pelvis, calyces, and renal tissue with urine, due to a partial or intermittent obstruction to the exit of urine. Complete and permanent occlusion causes, not hydronephrosis, but arrest of secretion and atrophy of the kidney.

The *obstacle* to the passage of urine from the kidney may be located in the *ureter*—such as a stone, blood-clot, valvular arrangement of the mucous membrane, a "kinking" due to displacement of the kidney; or in the *bladder*, such as a tumor at the ureteral orifice, a calculus, or prostatic enlargement; or, finally, in the *urethra*, as a tight stricture or a minute meatus. As some of these conditions are congenital, hydronephrosis likewise may exist at birth.

The effects of such obstruction are gradual dilatation of the pelvis and kidney tissue, and finally atrophy of the latter, the kidney and its pelvis being transformed into a membrane-like sac. This sac may contain many ounces, even gal-

FIG. 220.

Hydronephrosis from obliteration of ureter by tubercular disease (Tuffier).

lons, of fluid, which, while at first urine, gradually loses its urinary constituents and assumes a cystic character. If infection occur, a suppurating hydronephrosis, and finally pyonephrosis, results.

SYMPTOMS.—The gradual development of a hydronephrosis occasions no pronounced symptoms, although the obstructing cause, such as a calculus in the ureter, may produce acute signs. Sometimes a dull pain is observed and undue frequency of urination noted; commonly, however, the swelling is the first symptom. Sometimes this tumor undergoes rapid decrease in size corresponding to a greater escape of the retained urine, and such cases of intermittent hydronephrosis are apt to have mild renal colic.

The DIAGNOSIS is made probable by the history and detection of a fluctuating tumor; it should be confirmed by careful aseptic aspiration, which alone can furnish positive differentiation from other kidney tumors and from ovarian cysts.

TREATMENT.—Rational treatment would be the removal of the obstruction. To this end medicines are useless: a few cases have been relieved by mechanical means, such as massage of the tumor, inversion of the

patient, or aspiration through the loin. Usually, however, operative interference is necessary.

Surgical treatment may be either *nephrotomy* or *nephrectomy*, made through a lumbar or transperitoneal incision, most surgeons preferring the former.

Nephrotomy—or more accurately *pyelotomy*, since in this case the distended pelvis rather than the kidney is incised—is the operation of choice,

FIG. 221.

Hydronephrosis in first stage of development (Rayer).

the sac being stitched to the skin. Then a careful search is made for obstructions in the ureter; a stone or clot is removed, a stricture divided, etc. Often the obstruction cannot be detected nor removed, yet sometimes the result is a cure even when nothing beyond simple incision and drainage is done. If, however, a permanent fistula, discharging large quantities of urine, persists, the advisability of nephrectomy must be considered.

Cysts.—Two varieties of renal cysts come to the attention of the surgeon—*conglomerate* (cystic degeneration) and *hydatid*.

Cystic degeneration of the kidney is often congenital, and sometimes in later life acquired; usually both kidneys are involved. It causes vague symptoms suggestive of chronic nephritis—light, pale, albuminous, perhaps bloody urine; cardiac hypertrophy; occasionally a perceptible renal tumor; œdema of the lower extremities.

Medical and surgical treatment are alike useless.

Hydatid cysts of the kidney are rare, and cannot be distinguished from other fluid tumors unless the characteristic hooklets or daughter-cysts are discovered in the urine, or by aspiration, or after rupture into adjacent organs.

The TREATMENT is incision to the tumor, evacuation of the sac, excision of so much of it as is accessible, and stitching of the remainder to the skin.

A few cases seem to have recovered after the injection of half a drachm of mercuric bichloride solution (1 : 1000) into the cyst, whereby the parasite is destroyed and absorption of the cystic contents promoted.

Neoplasms (solid tumors) of the kidney are *benignant* or *malignant;* the former are not common. The malignant tumors—*carcinoma, sarcoma*—occur as secondary or primary growths; the latter are most frequent in infancy and in advanced life, often attaining great size in the younger patient—ten to twenty pounds. The cancer remains for a long time enclosed within the kidney capsule, though metastases may early occur.

The SYMPTOMS of renal cancer are pain, hæmaturia, dilatation of superficial veins, tumor, and cachexia; the latter is the only constant feature. Pressure upon the common iliac vein or vena cava may cause œdema in one or both extremities, as well as enlargement of the veins in the abdominal wall, scrotum, and leg.

The pain is more often dull than sharp or paroxysmal, though renal colic, due to plugging of the ureter by blood-clots or detached fragments of the cancer, may occur. The bleeding is intermittent, often severe, and appears without provocation.

The DIAGNOSIS is not always possible until the kidney is exposed; the cachexia peculiar to cancerous patients and emaciation are important diagnostic signs.

TREATMENT.—There is but one, *nephrectomy.* Cases in which the tumor and kidney have been extirpated before metastatic deposits existed have furnished a large percentage of cures; unfortunately, the difficulty of diagnosis has often prevented early operation.

MOVABLE AND FLOATING KIDNEY.

Abnormal mobility of the kidney may be congenital or acquired, and the range of movement may be behind the peritoneum, due to laxity of the renal attachment, or within the abdominal cavity, due to the enclosure of the kidney in a distinct envelope of peritoneum—a *meso-nephron.* The former is called a *movable* kidney, the latter—far less frequent—a *floating* kidney; this anatomical distinction is not clinically practicable until the kidney is exposed.

Practically, every abnormally motile kidney is a movable kidney; the condition is *acquired*, not congenital; in at least 90 per cent. of cases it is found in women, especially in those who have borne several children.

SYMPTOMS.—Pain varies from almost nothing to a severity that incapacitates the patient for active bodily movement. In the latter case a dragging pain in the abdomen, aggravated by movement, standing, constipation, or menstruation, sharp pain, resembling renal colic, general abdominal distress with nausea, are frequently observed.

Palpation reveals a tumor which usually corresponds in size and shape with the normal kindey, though sometimes larger; this may be found even as low as the pelvic brim; indeed, it has been felt through the vagina: it can generally be pushed back into the normal locality either by the hand or by elevation of the patient's hips.

TREATMENT aims at the retention of the kidney in its normal position: to this end various trusses and bandages have been devised, and have sometimes in thin patients secured a proper fixation of the kidney. Usually, however, this organ must be exposed, and by means of three or four silk sutures, passed half an inch apart through the kidney substance and the edges of the divided lumbar fascia, sewn firmly to the abdominal wall. This operation is termed *nephropexy* or *nephrorrhaphy*: it is almost free from danger and affords a great probability of permanent relief.

RENAL COLIC.

Spasmodic contractions of the kidney pelvis and ureter are accompanied with agonizing pain, called renal colic; painful retraction of the corresponding testicle is a common accompaniment. These contractions are provoked either by the irritation of a calculus in the pelvis or ureter or by any decided obstruction to the passage of urine into the bladder. They therefore occur in several conditions other than renal calculus, being caused by blood- or pus-clots, renal tuberculosis or malignant disease; kinking of the ureter in cases of movable kidney; stricture or compression of the ureter by pelvic tumors or inflammatory exudates.

The TREATMENT should aim ultimately to remove the cause of the obstruction, but the severe pain requires present relief. The patient should be more or less completely inverted, a measure sometimes giving immediate and lasting relief from pain; if it fail, hot fomentations, subcutaneous injections of morphine, or even prolonged inhalations of chloroform, are required.

PERINEPHRITIS.

Inflammation of the fatty and connective tissue surrounding the kidney is a somewhat frequent condition; it is sometimes secondary to a general septic infection or to inflammation in adjacent organs—appendix, liver, colon; and it is frequently primary. The usual CAUSES of primary perinephritis are wounds and blows in the lumbar region, infections of the kidney substance and pelvis (pyelitis, tuberculosis), and perhaps the so-called gouty diathesis.

The COURSE of the perirenal inflammation varies with the cause; it results sometimes in a chronic thickening of the tissues, more commonly in suppuration. The abscess may long remain limited to the perirenal region, or it may soon burst into the colon, lung, peritoneum, or externally, or it may burrow down into the pelvic connective tissues.

SYMPTOMS.—The usual acute form is marked by the regular symptoms of septic inflammation—chills, fever, pain, and tenderness: there may be fixation and tenderness of the hip, closely simulating

tuberculosis of this joint, but a distinct fulness of the lumbar region is apparent.

The DIAGNOSIS is established by the aspirating needle.

TREATMENT.—In many cases the morbid condition in the kidney itself overshadows the perinephritic inflammation both as to diagnosis and treatment. The perirenal process should be treated as are other septic infections; that is, before suppuration is evident by the external application of guaiacol, and after pus-formation by *incision* and *drainage*. Guaiacol, 15 to 30 minims, mixed with a equal volume of olive oil or glycerin, should be rubbed into the skin over the kidney two or three times daily; absolute rest and saline laxatives are required. If chills and high temperature or the aspirator reveal the presence of pus, incision and drainage should be promptly made; delay increases the possibility of rupture of the abscess into the peritoneum or of its burrowing into the pelvis.

NEPHRALGIA.

Pain referred to the kidney is an obvious result of many of the morbid conditions already discussed, such as calculus, cancer, and ureteral obstruction. There are, however, cases in which severe and persistent pain in the kidney cannot be accounted for by an obvious lesion. In some of these a gouty condition associated with unduly acid urine has been assumed as the cause, and appropriate medical treatment has followed by diminution of the pain. In others, after the failure of internal remedies, an exploratory incision to or into the kidney has been made; in some of these cases a small calculus has been discovered and removed; in others, although nothing abnormal was detected, the pain has immediately and permanently ceased. In cases of severe and persistent renal pain, therefore, the failure of internal medication and of the local application of guaiacol justifies the consideration of an exploratory nephrotomy. Renal pain must be carefully distinguished from the frequent pain in the sacral region caused by chronic inflammation of the prostate and appendages.

RENAL HÆMATURIA.

This is another symptom which, while regularly associated with obvious kidney disease, such as calculus and cancer, occurs in some cases without apparent cause. In some of these the bleeding seems to be due to malarial infection, because promptly relieved by quinine; in others the later history or an exploratory incision reveals malignant disease or a calculus; in at least one case excision of a kidney for prolonged and dangerous hemorrhage has shown a local brittleness of the renal vessel (local hæmophilia). But many cases are on record in which an exploratory incision, while disclosing no abnormality, has been followed by permanent arrest of hemorrhage.

Oil of turpentine in five- to ten-drop doses on sugar four times daily, and thorough massage of the abdomen and lumbar region, should be tried before operative measures are considered. The fact that these cases of apparently causeless bleeding from the kidney, arrested by simple incision, commonly occur in young women suggests the possibility of an emotional disturbance as a cause.

DISEASES OF THE TESTICLE AND EPIDIDYMIS.

THE *acute* diseases of these organs are due to *gonorrhœa, septic infection,* and *trauma,* all of which have been described in Volume I.; acute inflammation of the testicle is also seen as a local manifestation of the general infection of mumps, typhoid fever, and other acute bacterial diseases. It requires the same treatment as gonorrhœal orchitis.

The *chronic* diseases are all accompanied by *enlargement,* general or local, of these parts, and the diagnosis of these diseases is therefore largely a comparative study of the swellings exhibited by these organs.

Tuberculosis is primarily a disease of the epididymis, where the infection appears as irregular, hard, nodular swellings like shot, which may later coalesce into a cord, thus converting the epididymis into a rigid tube as large as the finger; subsequently the same changes may occur in the adjacent parts of the testicle and in the spermatic cord. The tubercular tissues in the epididymis may become adherent to the skin, soften, and ulcerate, making a small but obstinate sinus.

Tuberculosis of the epididymis is soon followed, usually before the patient seeks medical advice, by the infection of the seminal vesicle and prostate; the remarks as to the age of patients, avenues of infection, and general treatment of "tuberculosis of the prostate and appendages" are therefore applicable here.

Surgical TREATMENT was formerly castration, with the idea of removing the tuberculous focus and thus protecting the patient from further infection. Experience has, however, shown the fallacy of this idea, since the infection is usually established within the pelvis before the patient is brought to the surgeon. Conservative local treatment is the wise plan: before softening of the tuberculous foci has occurred guaiacol (twenty drops with an equal quantity of olive oil) should be rubbed into the diseased parts two or three times daily until the skin becomes sore, and then applied to the spermatic cord and groin. After softening has occurred the tissues should be thoroughly curetted and packed with iodoform gauze: if the infection and softening have already involved most of the testicle, castration should be performed, not with the idea of preventing further infection, but simply (like the curetting) to remove broken-down tissue. Trichloride of iodine (1 part to 100 or 300 of pure water) has, in the writer's hands, proved a most valuable agent for application to tuberculous cavities and tissues in the epididymis and testicle.

Syphilis in the *secondary* and *tertiary* stages attacks first the *testicle,* and later the *epididymis and cord,* thereby offering a sharp contrast to tuberculosis of these parts. It makes a diffuse, smooth, painless enlargement of the testis, which may double or triple the original size of the organ.

The DIAGNOSIS must rest partly upon the history, but chiefly upon the effects of specific treatment—full doses of the iodides internally and blue ointment or other mercurial salve locally. Syphilitic enlargement of the testicle is extremely common, and it usually occurs years after the primary infection, when the patient has perhaps almost forgotten the incident: it is therefore an excellent rule never to remove a smooth, painless tumor of the body of the testis until a month of active treatment with iodides and mercurials has failed to make any impression upon it.

Within six months after the infection is acquired syphilis occasionally attacks the epididymis. This swelling is easily distinguished from the tuberculous infection, not only by the recent history, but also by the smoothness and painlessness of the enlargement. It yields readily to syphilitic treatment.

Cystic Disease.—In middle life the testicle presents a cystic degeneration distinct from the cystic formation that often accompanies sarcoma. It is a slowly-growing, painless tumor, whose fluid nature may be suspected from its indistinct fluctuation (which is, however, also shown by sarcomata); the aspirating needle can alone establish the diagnosis.

MEDICAL TREATMENT is useless; *castration* is usually performed. However, since the cystic degeneration may involve only a part of the testis, it may be well for the surgeon after exposing this organ to incise it, and, if a considerable portion seems normal, to remove only the diseased part.

Chronic Epididymitis and Orchitis.—Sometimes as a continuation of an acute infection, oftener as a purely chronic inflammation, the epididymis and the testis, one or both, exhibit a chronic enlargement designated by the above names. This condition seems often to be a continuation of the chronic inflammation so common in the prostate and seminal tubes, and already described in the "Diseases of the Prostate and Appendages." Sometimes the epididymis is alone affected, sometimes the testis alone, or both may exhibit the enlargement. This chronic inflammation causes a great and often uniform swelling of the organs; they are painful and sensitive to pressure. Acute aggravations of the inflammation, resulting in local abscess and sinus, are not rare, and ultimately cysts may develop.

The DIAGNOSIS is sometimes very difficult; indeed, this condition is probably often considered tuberculous, cystic, or malignant disease, and castration is performed on this mistaken diagnosis. It must be distinguished from other enlargements by a careful comparison of the symptoms, by examination of the prostate and vesicles, and by the effects of syphilitic treatment.

TREATMENT.—When chronic inflammation of the prostate and appendages is discovered, these should be treated by milking and irrigation, as already described; in any case the effects of mercurial ointments to the testicle should be tried. Otherwise, the treatment is symptomatic—suspension of the organ, curetting of sinuses and abscess-cavities, etc. Ultimately castration is necessary in a considerable number of cases.

Fibroma and **enchondroma** of the testicle are rare and clinically unimportant.

Cancer of the testicle is a term used to designate two varieties of malignant growth, *carcinoma* and *sarcoma*, the distinction between which is often impossible without histological examination.

Cancer of the testis is most frequent in the second half of life, though not rare before the completion of puberty. Its origin can often be distinctly traced to a blow, or a previously inactive tumor shows a rapid and malignant growth after such injury.

In the early and slow stages there are no sharp diagnostic distinc-

tions from the non-malignant enlargements of the testicle already mentioned : the active stage is, however, marked by *rapid enlargement, constant pain, dilatation of scrotal veins, induration of the inguinal and pelvic lymph-nodes*, and the *cachexia and emaciation* generally characteristic of malignant growths. The aspirating needle brings only blood.

TREATMENT consists of castration and removal of infected nodes. Yet the records show a discouragingly large percentage of metastases in internal organs even after fairly early castration ; the transfer of cancerous material to the pelvic nodes seems to occur at a startlingly early period.

DISEASES OF THE SPERMATIC CORD.

While the vas deferens and its envelope participate in many of the diseases of the testicle and epididymis and of the prostate and seminal vesicle, it exhibits three independent morbid conditions—*hydrocele, spermatocele*, and *varicocele*.

Hydrocele of the cord is a collection of serous fluid in a portion of the peritoneal process surrounding the cord which has not undergone the usual obliteration after the descent of the testicle. It causes a painless swelling in the position of the spermatic cord and terminating above the testicle ; its upper end may lie within the inguinal canal.

It causes no SYMPTOMS, unless acute inflammation supervenes, when tenderness and pain are developed.

The DIAGNOSIS is best made by an *aseptic aspiration*, which may also be the means for immediate injection of three or four drops of 95 per cent. carbolic acid by way of treatment. Without aspiration it may be possible to recognize a hydrocele by its shape and distinct fluctuation, but it is sometimes difficult to distinguish it from omental or even intestinal hernia, with which it may indeed be complicated. When injection of carbolic acid fails, the *sac may be incised*, stitched to the skin, and packed with iodoform gauze.

Spermatocele begins between testicle and epididymis, but extends upward along the spermatic cord, making an oval fluctuating tumor which appears to be inserted at the top of the testis or epididymis.

The DIAGNOSIS is confirmed by microscopic examination of the fluid removed by aspiration (showing spermatozoa) ; if, after tapping, it again form, the sac may be opened and stitched to the skin.

Varicocele—*dilatation of the veins of the pampiniform plexus and of the spermatic cord*—is a very common affection, found in perhaps 10 per cent. of adult males. Its clinical importance depends quite as much upon the popular belief that it causes sexual derangement as upon its real pathological effects.

Varicocele commonly develops soon after puberty, when the sexual instinct is constantly active and imperfectly gratified ; a slight degree of venous dilatation often disappears after marriage. Varicocele is but rarely observed in the right half of the scrotum ; its almost constant restriction to the left side is usually explained by the tendency to venous congestion caused by two factors : first, the opening of the left spermatic vein into the renal vein at a right angle, and, second, the frequent compression of this left spermatic vein by a distended sigmoid flexure.

Symptoms.—The development of the varicose condition is nearly always gradual ; in rare cases—following violent bodily effort or fatigue —it is acute. This acute form usually subsides under a few days' rest, hot fomentations, and elevation of the testicles.

The usual slowly-developing varicoceles are often discovered by accident before they have caused any subjective symptoms, but sooner or later the patient becomes aware of a sense of weight, possibly dull pain, in the testicle and sacral region, aggravated by bodily effort and by sexual excitement. In extreme cases the veins of the scrotum also exhibit the varicose condition. Mental symptoms—anxiety and despondency concerning the integrity of the sexual organs—are frequently pronounced, and the testicle may, in fact, become soft, sensitive, and ultimately atrophied.

The DIAGNOSIS of uncomplicated varicocele is simple : the wormy feel of the tortuous vein is quite peculiar and unmistakable. If the patient be made to lie down, the dilated veins are emptied and the enlargement disappears ; if he again stand, the surgeon's fingers being meanwhile kept pressed against the external inguinal ring, the veins refill from below (unless the pressure is so great as to obstruct the artery also). The coexistence of hydrocele or hernia can be detected by this test.

Treatment.—There are three symptoms requiring treatment : (1) a *hypochondriac state ;* (2) such *pain and distress* in the testicle, groin, and back as to seriously annoy and incommode ; (3) *wasting of the testicle.* If none of these exist, the patient may be dismissed with advice as to sexual hygiene and with a suspensory bandage. If the mental symptoms are prominent, general tonic treatment and cold douches locally should also be prescribed. If, in spite of support and mental treatment, either of the three symptoms persist, an operation should be advised. This is especially needful if the testicle be flabby, sensitive, or wasted ; for after ligation of the varicose veins the condition of this organ improves—often, indeed, to the normal standard.

Three operations for varicocele are more or less practised : (1) the *amputation of the scrotum,* which converts this sac into a natural suspensory bandage ; (2) *subcutaneous ligation of the dilated veins ;* (3) *open ligation and excision of these veins.*

Amputation of the scrotum may be dismissed as an uncertain and unnecessarily severe operation : the choice really lies between subcutaneous and open ligation of veins. The former is practised and warmly advocated by several skilful surgeons, notably Keyes, while the open method has the general preference, because by it the surgeon can see what and where to ligate.

In *ligation of the veins,* whether subcutaneous or open, three vital points must be observed : (1) the vas deferens must be excluded from the ligature ; (2) at least three or four venous trunks must remain untied; and (3) the veins must be tied at the bottom as well as at the top of the scrotum—that is, at the globus minor of the epididymis as well as in the spermatic cord. The exclusion of the vas deferens secures the patulence not only of this important duct, but also of the spermatic artery which accompanies it : ligation of this artery has been known to cause necrosis or atrophy of the testicle. The obliteration of all venous trunks also renders atrophy of the testis probable ; hence the necessity for leaving some untied.

The third injunction—to tie at the bottom as well as at the top of the scrotum —is the result of the frequent experience that ligation of the veins above the testicle only (in the spermatic cord) has often failed to cure the varicocele; for the veins of course fill from below, and such ligation leaves a large mass of dilated veins around the testicle constantly full of blood.

The *operation* is thus performed : The patient's groin and scrotum are thoroughly shaved and cleansed ; a clean rubber band, applied while the patient stands, is made to constrict the scrotum, passing over the root of the penis : this organ is enclosed in aseptic gauze and kept out of the way against the suprapubic space by a bandage around the hips. Anæsthesia may be general or local (two drachms of a 1 per cent. cocaine solution injected into the skin over the cord and epididymis). A longitudinal incision two inches long divides the scrotum below the rubber band ; the enlarged veins are lifted into the wound ; the vas deferens—distinctly recognizable as a hard cord—is kept carefully away from the wound by the thumb and finger of an assistant ; the bunch of veins, excluding three or four, is very tightly ligated *en masse* with silk at two points, above the testicle and opposite the globus minor ; some surgeons place a third ligature between these two. The ligatures are cut short ; a drain consisting of a few strands of catgut is carried through a puncture in the bottom of the scrotum ; the wound dusted with iodoform and closed ; iodoform gauze dressing and rest in bed for a week follow. After this, as after other operations on the genitals or rectum, temporary retention of urine may occur, requiring the catheter for a day or two.

HYDROCELE.

By *hydrocele* is meant an accumulation of serous fluid in the tunica vaginalis ; it may be *acute* or *chronic*. The acute form is always second-ary to trauma, inflammation of epididymis or testicle, or a general infec-tion such as pyæmia.

It usually subsides without other TREATMENT than rest and hot fomentations ; if suppuration occur, incision and drainage are needed. *Chronic hydrocele* is the condition meant by the term hydrocele unless otherwise specified.

The fluid accumulates slowly and lasts indefinitely ; the tunica and the sub-serous connective tissue may become greatly thickened and hardened ; calcareous deposits are observed and osseous formations are sometimes seen. The extreme thickening may involve the scrotum ; the opposing surfaces of the tunica become adherent, the fluid absorbed, and the entire mass—the testicle and its greatly thick-ened covering—constitute a solid tumor suggestive of cancer. This condition is considered a chronic inflammation, and is called *periorchitis,* adhesive or prolife-rating.

SYMPTOMS AND DIAGNOSIS.—Chronic hydrocele causes only mechan-ical symptoms—a swelling of the scrotum and a dragging sensation due to the extra weight.

The DIAGNOSIS is not usually difficult : the tumor is pear-shaped and sharply limited outside of the inguinal canal (unless there be also hydro-cele of the cord) ; there is more or less distinct fluctuation.

The classical test of *translucence*—interposing the tumor between a lighted candle and the surgeon's eye—usually shows the translucence of the greater part of the mass, the contained testicle and epididymis being opaque. This test is less successful when there is much thickening of the connective tissues. The modern test is a clean aspiration, which must always succeed except in cases of advanced periorchitis with absorption of the fluid.

TREATMENT.—There are two recognized modes of treatment : (1) the induction of an adhesive inflammation which shall unite the opposite

layers of the tunic and thus obliterate the cavity : this may be attempted by injection of irritating substances (carbolic acid) or by incision and packing (Volkmann's operation); and (2) excision of the entire tunica excepting only the part adherent to testis and epididymis.

Injection.—The scrotum having been carefully cleansed and the testicle grasped by the surgeon's left hand, a large aspirating needle is passed into the sac away from the testicle, the fluid permitted to escape, and ten to twenty minims of 95 per cent. carbolic acid injected; the sac should then be so manipulated as to spread the injected acid over its surface—an important item. The patient is kept quiet for a day or two, and then permitted to go about with the testicle properly supported. The scrotum again swells and becomes doughy, as if refilling with fluid, but in a week or so the new swelling subsides permanently.

Cautions.—Tincture of iodine, formerly so much used for this injection, should *never be employed*, because the inflammatory reaction is sometimes extremely severe and followed by sloughing of the scrotum, with perhaps a fatal result.

Great care should be taken, before the acid is injected, to see that the point of the needle is still within the cavity of the tunica; for the collapse of the sac as the fluid escapes may leave the needle outside of the serous cavity, in which case the acid would be injected into the scrotal tissues, causing serious damage.

The only objection to this operation is its uncertainty, relapses of the hydrocele being frequent.

Free incision and packing of the sac with iodoform gauze, the cut edges of the tunica being sewn with catgut to the edges of the skin, is a simple and safe operation (done aseptically) which can be performed under cocaine anæsthesia. Unfortunately, it is not a certain cure, recurrence having been occasionally observed.

Excision of the sac, which can usually be peeled away from the adherent scrotum before the sac is opened, is the only positive cure : the objections are, first, that it requires general anæsthesia, and, second, that very free oozing of blood may occur from the raw surfaces unless firm pressure is maintained for a day or two after operation.

OPERATIONS.

The following operations, needful for the relief of various morbid conditions, have not been described in the text.

Circumcision.—The patient, if a child, should be chloroformed; in an adult local anæsthesia is induced, after constriction of the penis by a rubber band around its root, by the subcutaneous injection into the dorsum of the organ just in front of this band of a half drachm of a 10 per cent. cocaine solution. The parts are cleansed; a snap forceps seizes the muco-cutaneous junction of the foreskin on either side : by means of these an assistant draws the prepuce well forward from the glans, which is pressed back by the left hand of the operator. With sharp scissors (with or without the aid of a clamp) the foreskin is amputated just in front of the glans. The skin now retracts, while the cuff of mucous membrane remains over the glans; this cuff is split with scissors in the middle line (sometimes adhesions to the glans must be broken up by means of a probe), and each segment cut off close to the penis, leaving a fringe only about a quarter of an inch broad. The skin, if excessive, must be again drawn beyond the glans and another section snipped off. The constricting band is removed, any spurting vessels are twisted or ligated, and the cut edges of skin and mucous membrane are united by eight to

twelve interrupted catgut sutures, the stitches passing through the inter-
vening subcutaneous tissues. The seam is dusted with iodoform or lore-
tin, dressed with gauze, and a rubber condom (whose narrow neck is
split to avoid constriction) is drawn over the hole. The tip of this con-
dom is then cut off and the edges fastened to the surface of the gland
with collodion, to prevent leakage of urine into the dressing.

Cautions.—The essential of success is the complete removal of redundant fore-
skin, especially of the mucous layer, of which only enough should be left for the
insertion of stitches—not more than one-fourth of an inch. A broad fringe results
in great swelling, often suppuration, and after healing an unnecessary deformity
due to redundant tissue. This removal of the mucous layer should be done with
especial thoroughness on the under surface of the penis.

In amputating the foreskin the scissors must, of course, not be permitted to cut
the glans itself. Some œdema, perhaps ecchymosis, occurs at the point of cocaine
injection.

Free evacuation of the bowels and bromide-of-camphor pills at night will assist
in preventing painful erections and oozing of blood during sleep. The wound is
re-dressed in three or four days, and should be entirely healed in eight or ten
days. The patient need not keep his bed at all, though the healing is more rapid
if he does so.

External Urethrotomy.—In this operation, also called perineal and
membranous urethrotomy, the membranous urethra is opened by an
incision through the perineum. It is thus performed :

The patient is anæsthetized, the rectum evacuated, the bladder irri-
gated, and five or six ounces of an antiseptic fluid injected into it ; the
perineum and posterior scrotal wall shaved and cleansed. The legs and
thighs are held fully and symmetrically flexed (lithotomy position) ; a
grooved staff introduced until its point enters the prostatic urethra and
its shaft stands about vertically, is firmly held by an assistant, who keeps
the beak well against the under surface of the symphysis. The scrotum
is held upward, exposing the perineum ; with a long-bladed, full-bellied
scalpel the surgeon makes a vertical incision an inch long through the
skin in the median line, its lower end about an inch above the anus. The
lubricated fore finger of the left hand is then passed into the rectum and
rests against the staff where it enters the prostate. The knife is then
turned edge upward and held horizontally ; its point is entered at the
lower end of the skin incision, and is thus passed through the perineal
tissues till the point enters the groove of the staff ; this movement can
be guided by the finger in the rectum. The knife, still held horizontally
and its point kept in the groove, is then drawn upward until its shaft
reaches the upper end of the skin incision ; by this movement the mem-
branous urethra is freely opened. The knife is then drawn horizontally
toward the operator and away from the staff, cutting its way out. A
grooved director or stiff probe is then passed into the incision to the staff,
and along the groove of the latter into the bladder. The staff and finger
in the rectum are now withdrawn, and the fore finger of the right hand
worms its way through the wound, along the director as a guide, into
the bladder. A drainage-tube is passed about an inch into the bladder (if
of rubber, it should be held in position by a silk suture through the cut
edges of the skin) ; the bladder, urethra, and wound are well irrigated ;
iodoform gauze is lightly packed around the tube, and a T-bandage
applied.

Perineal Section.—This differs from the operation just described,

external urethrotomy, in that it is made without a guiding staff: the term is applied to the operation in cases of stricture too tight to permit the introduction of a guide through the membranous urethra. A staff is, however, passed as far as possible, since its point aids the surgeon in locating the position of the membranous urethra.

It is identical with the former operation, except that a narrow knife with long blade is used, and that this knife, instead of being passed through the perineum into the groove of the staff, is steadily and cautiously passed, guided by the finger in the rectum, to the point where the staff ought to be—that is, to the apex of the prostate. The knife is withdrawn and a director or probe introduced into the wound and the prostatic urethra. The space between this director and the end of the staff is the location of the membranous urethra, which should then be carefully opened with a knife, and a full-sized sound passed into the bladder before the director is withdrawn. The operation is by no means so simple as the description; indeed, it is apt to be one of the most trying and delicate procedures in urinary surgery.

Suprapubic Cystotomy.—The patient is anæsthetized, the rectum emptied; pubes, scrotum, and perineum are shaved and cleansed; the bladder is well irrigated; five to eight ounces of warm antiseptic fluid are injected and retained by a light rubber band around the penis. The patient is placed in the Trendelenburg position—that is, on an inclined plane which raises the hips twelve to eighteen inches above the shoulders. An incision three inches long, its lower end half an inch below the upper border of the symphysis, is then made in the median line down to the recti muscles; these are separated by the handle of the scalpel and kept apart by blunt retractors. The operator's finger is then passed down the posterior surface of the symphysis to the bladder and presses the pre-vesical fat upward toward the peritoneal fold. A tenaculum seizes the muscular wall of the bladder near the upper angle of the wound; a sharp-pointed knife is then plunged through the bladder-wall near the symphysis, making a cut half an inch long, and is quickly followed by the finger before the contained fluid escapes. After the calculus, vesical or prostatic tumor has been removed and the bladder irrigated, a large rubber drain with lateral openings at the end is passed through to the base of the bladder and stitched to the skin: around this iodoform gauze is lightly packed, and the upper end of the wound is closed by sutures passing through skin and recti muscles. The usual dressings are applied around the tube.

Many modifications of this procedure are used in special cases: sometimes the bladder is distended with air instead of water—an excellent plan when the bladder is weakened by ulceration, since the danger of rupture is less. Some surgeons still distend the rectum by means of an oblong rubber bag (Peterson's); some stitch the cut edges of the bladder to the edges of the skin wound. While none of these measures are desirable as routine practice, yet it is usually wise (especially if the urine be foul) to make a perineal urethrotomy, insert a metal drain (Watson's or Belfield's), and close the supervening bladder wound with catgut sutures, leaving a strip of iodoform gauze in the wound above the bladder. The danger of septic infection and peritonitis is greatly diminished by this method.

Nephrotomy.—The kidney may be reached by an incision through the loin or through the abdominal wall: the former is, for obvious reasons, the incision of choice, and the latter is rarely necessary.

The lumbar incision should begin at the outer margin of the sacro-lumbalis muscle (two to four inches from the spinous process) about half an inch below the last rib, and it should be extended parallel with this

rib for three or more inches, cutting down to the muscle. The muscular layers are separated down to the strong layer of lumbar fascia underlying the transversalis muscle: when this is divided in the line of the superficial incision, the perirenal fat is discovered, moving up and down synchronously with the respiratory movements of the diaphragm. The finger and thumb passed into the wound detect the kidney as a solid body which should be drawn into the incision and exposed by dissection of its fatty envelope. The organ being firmly grasped with the left hand, a sharp, narrow knife is passed from the convex border to the pelvis of the kidney and withdrawn, making an incision sufficiently large to permit the entrance of the operator's fore finger. A calculus is detected and removed or a flexible probe passed down the ureter: after the manipulations in the pelvis are concluded, the edges of the kidney wound are compressed for a minute or two, whereby hemorrhage is usually completely arrested. A rubber drain is stitched in the lower angle of the wound, which is lightly packed with iodoform gauze, the remainder of the incision being closed by deep and superficial sutures.

Fig. 222.

Incisions for exposing the kidney: *L*, longitudinal or vertical incision; *K*, transverse incision; *T*, König's incision (Stimson).

The one defect in the lumbar incision is the limited space afforded: to remedy this various procedures have been adopted. Thus, a pillow is placed under the opposite loin, the usual method; an assistant may firmly press upon the patient's abdomen so as to force the kidney into the wound. A great increase in space and convenience of manipulation can be secured by making a second incision, which shall extend from the middle of the first to the iliac crest—the so-called combined incision.

Since the twelfth rib is found to be rudimentary in about 5 per cent. of cases, *it is very important that the surgeon count the patient's ribs* before making the incision, since the knife entering half an inch below the eleventh rib would open the pleural cavity and cause a probably fatal collapse of the lung—an accident which has actually occurred.

Nephrectomy.—The combined incision already described affords the space necessary for removal of the kidney *unless this organ be greatly enlarged, in which case nephrectomy should be done by laparotomy.* When the combined lumbar incision has been made the fingers are gently insinuated around the ends and convex borders of the kidney, so as to separate it completely from its fatty capsule, leaving the renal vessels and ureter as a pedicle. When possible, the artery should be ligated separately, though sometimes it is necessary to tie all the vessels *en masse:* stout silk ligatures are passed around the vessels by means of large aneurism needles. Ligature *en masse* should be reinforced by a clamp to be left in position for forty-eight hours. During the entire manipulation great care should be taken not to pull strongly upon the renal vessels. The ureter should be ligated separately, and its stump sterilized with carbolic acid. The wound should be closed, drained, and dressed in the usual aseptic manner.

Spermato-cystotomy.—The seminal vesicles, when the seat of acute suppuration, can often be emptied into the urethra by gentle pressure with the finger in the rectum; in some cases acute distention of the vesicles with pus has been treated by incision from the perineum, the knife being guided by a finger in the rectum.

Chronic suppuration of the vesicles is likewise usually amenable to treatment by repeated milking or stripping of these organs, as already described. In some cases, however, persistent treatment by this method fails: in two such instances the writer has opened a chronically distended vesicle in the following way: The anæsthetized patient is laid upon the affected side, the rectum emptied, cleansed, and blocked with iodoform gauze about four inches above the anus. The sphincters are then stretched by the thumbs, and the anus kept patent by retractors. A longitudinal incision half an inch long is made through the mucous membrane of the rectum over the lower end of the distended vesicle; this sac is then gently drawn into the wound by means of an aneurism needle and incised; its cavity is explored and cleansed with a probe. In one case two small calculi, blocking the ejaculatory duct, were found and removed. Possibly this operation may be often useful in cases of chronic spermato-cystitis which have resisted less radical treatment.

DISORDERS OF INSEMINATION.

THE deposit of motile spermatozoa in the vagina—*insemination*—is the function of the male in reproduction. Imperfections in this function are known clinically as *impotence* and *sterility:* the former means inability to copulate, the latter (when not due to impotence) implies the absence of moving spermatozoa from the semen.

IMPOTENCE.

Inability on the part of the male to copulate, when not the result of malformation, is due to one of two phenomena—premature ejaculation or imperfect rigidity of the penis. Both are often exhibited by the same patient, the habit of early ejaculation having existed for some time before erectile power fails.

The PATHOLOGY of this condition is explained by a consideration of the process of normal copulation. The enlargement and hardening of the penis, constituting normal erection, is due to the distention of the cavernous and spongy bodies with blood: this distention is brought about by the dilatation of the penile arteries and the constriction of the venous exits; the latter effect is produced by the contraction of the perineal and penile muscles innervated by branches of the second sacral nerve proceeding from the genital centre in the lumbar cord.

This genital centre responds to a stimulus from either of two sources—the brain or the nerve-endings distributed in the penis from prostate to glans. Erection, then, may be induced through excitement of this centre by influences from above—sexual thoughts or congestion of the upper cord (as in the priapism which often follows fracture of the cervical vertebræ), or by influences from the periphery, such as friction of the glans, irritation of the same by a tight prepuce, congestion of the prostatic urethra by a distended bladder (morning erections) or by

gonorrhœal inflammation. The genital centre may also be directly stimulated by certain substances taken into the blood—cantharides, muscarine, alcohol.

Feebleness or complete absence of erection may therefore be due to any one of the following factors :

(1) *Inhibition of the genital centre* from the brain, induced by emotion—fear, anxiety, disgust, grief; such impotence is transient, ceasing when a normal emotional balance is restored.

(2) *Diseases of the spinal cord,* such as locomotor ataxia.

(3) *Exhaustion of the genital centre* by excessive activity, whether by intercourse or by masturbation.

(4) *Depression of the genital centre* through a vice of nutrition, such as diabetes mellitus and chronic alcoholism.

(5) *Disturbances of nerve-endings* in the genital organs—especially prostate and testicles—due to inflammation in these organs. This is clinically the commonest cause of impotence.

Ejaculation of semen is accomplished by the same nervous apparatus when stimulated to a higher degree, usually through friction of the peripheral nerves in the glans. It consists of a contraction of the genital muscles, beginning with the fibres on the broad ligament and seminal vesicles, and continuing through the prostate and perineal compressors. Premature ejaculation, like imperfect erection, may be caused by a mental influence or by disease of the peripheral nerves.

Clinically, the *most frequent cause of impotence is chronic inflammation of the prostate and appendages;* and this results either from gonorrhœal infection of these organs or from sexual excess, whether in venery or in masturbation.

The subject of this chronic inflammation often complains of pain in the sacrum (which he thinks indicates kidney disease), less frequently in the suprapubic region, perineum, rectum, testicles, and penis: the last-named organ is often cold and shrunken. Anxiety and despondency are marked; the patient frequently inspects the external organs, notes and broods upon every trivial deviation from what he considers the normal condition; he is sure that one testicle hangs down too far, etc.

The subject complaining of impotence should be carefully interrogated as to previous gonorrhœa and sexual excess; then a digital examination of testicles, prostate, and seminal vesicles should be made, the latter organs being gently pressed or "milked." This milking process often causes a discharge of milky-looking fluid from the meatus, in which the microscope reveals leucocytes, fatty epithelium, and sometimes motionless spermatozoa.

DIAGNOSIS.—*Two questions must be answered:* (1) *Does impotence really exist?* and (2) *To what is it due?* The patient's experience can alone answer the first question; the physician must estimate how much of the failure is due to emotional disturbance, for in some cases a man fails in intercourse simply because, having as a boy masturbated, he is terrified by the perusal of the quack circulars and pamphlets so widely distributed.

If imperfect sexual power seems likely to exist, it must next be decided to which of the recognized causes (above mentioned) this shall be attributed by the methods of examination already described.

TREATMENT.—The treatment of impotence will naturally depend upon the cause : when due to diabetes, etc., the treatment of the sexual deficiency is that of the general condition. When such morbid states have been occluded, the treatment is mental and local.

In some cases the emotional is the chief element: in nearly all it must be considered, for even when there is an organic cause, the mental despondency aggravates the trouble. The chief remedy for the emotional element is faith in an early recovery; and this should be encouraged when such faith is warranted. The next emotional remedy is prohibition of all sexual dalliance, not merely of intercourse; for the perversity of human nature makes this a valuable stimulus to the sexual desire and capacity, and such patients not infrequently confess after a time that they have successfully violated the injunction.

The *local treatment* is that for chronic inflammation of the prostate and appendages already described—"milking" of these organs, the passage of larger sounds, deep injections of hydrastin or weak silver-nitrate solution, alternating hot and cold sponging of the perineum and external genitals, and pills of camphor monobromide. In cases of exhaustion of the genital centre by sexual excess, rest from all sexual excitement is imperative; mental and physical diversion is important; strychnine, phosphorus, and belladonna are sometimes useful.

The PROGNOSIS varies with two factors—the cause of the impotence and the age of the patient: the most favorable cases are those due to gonorrhœa and in young or middle-aged men; these usually recover completely in a few months. In cases of impotence due to sexual excess the prognosis is less favorable.

Treatment must usually be continued for several months.

STERILITY.

In the majority of unfruitful marriages the cause of sterility is located in the female; in a minority—perhaps 10 per cent.—in the male.

Failure to fertilize the female may be due either to *inability to eject the seminal fluid into the vagina* (impotence) or to the *absence of motile spermatozoa* from that fluid (*sterility proper*): the latter condition may coexist with perfect power to copulate. In some cases no spermatozoa whatever are found in the semen—a condition known as *azoöspermia*, and due either to lack of secreting cells in the testicles or to obstruction in the seminal canals. The fibroid or *eunuchoid* testicle usually produces no perfect spermatozoa, and testicles retained in the abdomen or groin are apt to be sterile. Obstructions to the passage of spermatozoa may be due to malformations or to inflammatory exudates in epididymis or ejaculatory duct (from gonorrhœa) or urethra (stricture).

Sometimes the semen contains perfectly formed spermatozoa, which are, however, even when first emitted, nearly or quite motionless: this absence of motion, entailing sterility, is due to a catarrhal condition in some part of the seminal tubes, especially the prostate and seminal vesicles; for the spermatozoa, motionless in the testicle, are normally aroused to movement by contact with the prostatic secretion; when this is abnormal from chronic inflammation of the prostatic follicles, the spermatozoa may exhibit feeble movements or none at all.

The TREATMENT of sterility is determined by the cause: if examination of the freshly-passed semen (received in a condom) shows no spermatozoa, treatment is useless unless a chronic double epididymis exist, in which case persistent massage of the indurated tissues with mercurial ointment may be made. If spermatozoa be present, but motionless, the usual treatment for chronic inflammation of prostate and vesicles should be instituted.

Involuntary Seminal Discharges.

These occur in two ways—as *nocturnal emissions*, caused by contractions of the genital muscles, and as *spermatorrhœa* due to the muscular contractions incident to defecation and micturition.

Seminal emissions with the nocturnal orgasm, occurring during sleep and preceded by an erotic dream, are experienced by healthy, continent men at intervals of ten to thirty days: when not followed by languor and fatigue, they may be considered compatible with health.

Emissions occurring at short intervals, and followed by lassitude and sacral pain, usually indicate abnormal excitement of the genital tract. They are common in boys and young men who have practised masturbation for a long time; also in those who indulge in sexual excitement without intercourse; and they often result from the extension of a gonorrhœal inflammation to the prostate and seminal vesicles.

Frequent emissions cause great anxiety and despondency in youths who have practised masturbation and have been led to believe that nocturnal emissions inevitably cause early loss of virility.

Treatment.—The patient should be assured that involuntary emissions do not indicate destruction of the genital organs, and that the majority of boys have at some time practised masturbation. He should be instructed to avoid dalliance and ungratified sexual excitement. Constipation and alcohol must be carefully avoided.

Monobromide of camphor, two grains night and morning, will usually diminish the excitability of the genital centre in the cord, and thereby lengthen the intervals between nocturnal emissions. Local measures which reduce the congestion of the prostate and seminal vesicles, already mentioned, should be used—large, cold sounds, milking of the parts, deep injections of hydrastin, the hot and cold douche, etc.

Spermatorrhœa is the term designating the involuntary escape of seminal fluid, without orgasm or even erotic thoughts: it occurs almost always at the close of defecation or micturition. In the strict sense, which implies that the escaping fluid contains spermatozoa, this is a relatively rare condition, except as the result of straining at stool when the seminal vesicles are full, and this may happen to the healthiest man. The escape from the meatus of a few drops of milky fluid during defecation is, however, common: this fluid is usually *prostatic secretion* containing no spermatozoa, and the condition should be called *prostatorrhœa* rather than spermatorrhœa. Whether it contain spermatozoa or not, the habitual appearance of this fluid indicates a catarrhal state of the genital organs, which should be treated by the measures prescribed for chronic inflammation of the prostate and vesicles.

Pain during ejaculation and an admixture of blood with the semen are sometimes observed as the result of chronic inflammation of the prostate and vesicles.

CHAPTER XII.

CHANCROID OR VENEREAL ULCER.

By Roswell Park, M. D.

SINCE the day of John Hunter and his pupils, who confused the three totally different and so-called venereal diseases, pathologists have drawn a sharp and distinct line between *chancre*, which is simply the initial sore of syphilis (*vide* p. 187, Vol. I.), and *chancroid* or *venereal ulcer*, which is a distinctly local lesion, often destructive, but never followed by constitutional disease, save of septicæmic or pyæmic type. It is found usually upon the *genitals*, most commonly about the foreskin, glans, and vulva, but may be met with anywhere upon the body where infection may have occurred. It is distinctly **auto-inoculable**, in which respect it differs from chancre.

Although no distinct micro-organism has yet been identified as its active cause, there is good reason to think that there is a specific virus of some kind which causes it. Its course is characterized by local inflammation and tissue-destruction, without changes in the vessel-walls or surrounding induration.

Chancroid begins, even in twenty-four hours, as a red point or papule, which is quickly converted into a pustule, and then an *ulcer*. The borders of this ulcer enlarge, its depth increases, until after a few days it forms a more or less deep, often undermined excavation, irregular in contour, discharging grayish purulent material. In this respect it differs also from chancre, whose natural discharge is more like serum. In other words, *chancroid is essentially destructive, chancre constructive*, since the latter forms a new growth which ordinarily has little or no discharge. When the necrosis of chancroid becomes extensive and tends to spread rapidly, the ulcer is spoken of as **phagedenic**. This tendency to rapid local gangrene is the combined result, probably, of virulence of virus and lowered local or constitutional tissue-resistance. It is consequently most often seen in alcoholics and prostitutes. In rare instances a surface as large as the hand may thus be rapidly destroyed, every particle of material thus sloughed being extremely infectious. In chancroids of the mild variety the discharge may dry upon their surfaces and scabs or crusts result, beneath which, when detached, the characteristic ulcer is present.

Under proper treatment this foul ulcer is converted into an ordinary granulating surface, which heals by cicatrization, as described on p. 94, Vol. I.

Chancroidal Bubo.—Infection—by propagation along the lymphatics—of the inguinal nodes is very common, and, since the infection is almost always a *mixed* one, suppuration is quite frequent.

It is necessary to emphasize that the pus of a suppurating chancroidal bubo is often as infectious as the discharge from the original sore; hence it is wise to exercise great caution. Moreover, the edges of the local incision should be promptly cauterized, that they, too, may not become linear chancroids. Phagedena shows itself here as well as about the genitals proper, and differs only in that it makes the case more serious of its kind. Chancroidal bubo may, however, subside without abscess-formation, phagocytic activity being in such event most lively and most kindly. The signs of suppuration are those incident to pus-formation anywhere near the surface. When pus is present its early evacuation is called for.

DIAGNOSIS.—Chancroid is most likely to be confounded with *chancre* and *herpes preputialis.* Chancroid has no period of incubation. Destruction commences promptly after infection, so that ordinarily within twenty-four hours macroscopic evidence thereof may be observed, and within two or three days the sore has attained distinct size and shape. Apparent exceptions to this occur only when it is concealed from sight, as when within the urethra, vagina, or rectum, or beneath a tight foreskin. The *history* is then an important factor in diagnosis—*i. e.* the time which has elapsed between exposure and the commencement or discovery of the ulcer. *Confrontation,* when possible, may help in obscure cases: this means a careful examination of the partner in the sexual act from whom the disease is supposed to have been acquired. Chancroid lacks the characteristic induration of chancre, which has a distinct period of incubation, never less than ten days, usually twenty. (*Vide* p. 187, Vol. I.) Only when it has been mistreated or irritated will there be anything like condensation of tissue; usually the reverse obtains and œdema is common.

Herpes is a distinctly vesicular lesion, usually accompanied by pain and burning. The vesicles may be confluent, but never tend to destruction *per se,* nor to spread.

Chancroid.	Chancre.	Herpes.
Local ulcer.	First local sign of a constitutional disease.	Local neurosis.
A distinctly venereal infection.	Usually a venereal infection.	May be non-venereal, from friction, irritation, uncleanliness, etc.
No incubation; lesion noticed within few days.	Incubation from ten to seventy days before first lymphatic induration.	No incubation.
Commences as, and remains, an ulcer.	Commences as a papule, or occasionally an erosion. This *may* ulcerate later.	Commences as a crop of vesicles.
Usually multiple.	Usually single.	Multiple and occurring in crops or series.
Secretion purulent and abundant.	Secretion slight and serous or bloody.	Little or no secretion.
May occur again and again.	As a rule, only occurs once in same patient.	Patients who once have it are frequently subject to it.
Auto-inoculable.	Not auto-inoculable.	Not inoculable.
Phagedena frequent.	Phagedenic action very rare.	Never.
Buboes in about 65 per cent. of cases.	Bubonic enlargement nearly always.	Lymphatics rarely involved.
Buboes usually suppurate.	Buboes, as a rule, do not suppurate.	

PROGNOSIS.—Except in the most debilitated and dissipated, in whom phagedena may prove fatal, recovery always occurs, but often at the expense of considerable destruction of tissue and disfiguring scars.

TREATMENT.—In mild cases—*i. e.* those showing but little destructive tendency—absolute cleanliness and the use of hydrogen peroxide, followed by local use of such antiseptics as iodoform, aristol, loretin, etc., or even of calomel, will usually prove sufficient. If the ulcer manifest any tendency to spread, it should be cleansed, cocainized, and then cauterized with nitric acid or the actual cautery, after which it should be treated kindly to encourage granulation. This holds good still more in phagedenic cases, which may call for general anæsthesia, with the use of scissors and sharp spoon, followed by cauterization of every particle of raw or diseased surface.

Widespread phagedena is much more rare now than formerly. Cases which are extensive do best when submitted to continuous immersion of the hips in a sitz-bath as hot as can be tolerated. All aggravated cases call for invigorating and tonic measures, laxatives, improved nutrition, and sometimes for stimulants.

Suppurating buboes should be incised, often curetted, and thoroughly swabbed out with pure carbolic acid, then packed lightly with loretin gauze and allowed to close by granulation. Virulent cases will be accompanied by sloughing of so much tissue that it is best to remove all sloughs with scissors to save time. Here even stronger caustics will be called for. *Phimosis* often complicates chancroid, and will necessitate circumcision or incision along the dorsum of the prepuce, with such attention to the parts thus exposed as their condition may require.

Mixed chancre, or the combination of the two lesions, has been treated of on p. 190 of Vol. I., to which the reader is referred.

Extra-genital chancroid may occur upon any portion of the body, but is more rare than extra-genital chancre. It is characterized by the same peculiarities as pertain to the venereal sores already described.

CHAPTER XIII.

SURGICAL DISEASES AND INJURIES OF THE FEMALE REPRODUCTIVE ORGANS.

By James H. Etheridge, M. D.

Malformations.

The congenital malformations of the female genital tract which require operative treatment are not common. They are exclusively of the nature of **stenosis** or **atresia** of some part of the tract, and the symptoms which they cause are due either to the *retention of menstrual fluid* or to the *obstruction* which they cause to *copulation or delivery*.

The cause of these malformations is unknown. Most of them seem to be simply instances of arrested development, while others seem due to inflammatory processes during fœtal life.

One of the most common malformations is the **double vagina,** often accompanied by a *double uterus*. This condition usually causes no symptoms, and is discovered accidentally during a vaginal examination made for some other reason. If the uterus and vagina be double and one vagina show an atresia, we find fairly normal menstruation accompanied by the signs of vaginal atresia—namely, pain, pelvic tumor due to retention of menstrual fluids, etc. Rarely, when the vagina is double and the uterus single, the septum between the vaginæ becomes an obstacle to delivery and must be divided.

Atresia of the vagina is a more or less complete defect in the development of the vagina, so that there is no communication between the uterus and the external genitalia. It varies in extent from an imperforate hymen to a complete absence of the vagina. The lower part of the vagina is more frequently lacking than the upper. The external genitalia are usually normally developed. Usually there are no symptoms until puberty, and then only when the ovaries, tubes, and uterus are normally developed or the only abnormality is a double uterus. When ovulation begins the woman experiences the same general physical and mental disturbances observed during menstruation in a normal woman. Pain is present and persists during the intervals between the periods. It increases in severity as time goes on, and is due to the tension caused by the retained menstrual fluids. If the upper part of the vagina is developed, the blood collects there, forming a hæmatocolpos. As the amount increases the uterus and later the tubes are distended, causing hæmatometra and hæmatosalpinx. The distended uterus can be felt as a smooth, round, usually fluctuating tumor lying low in the median line of the pelvis. Sometimes the hæmatosalpinx can also be palpated. Pressure on the bladder and rectum causes functional dis-

turbances, incontinence, retention, and tenesmus. The pains in the legs and the œdema sometimes seen are also due to pressure. *Direct examination* shows a normal vulva, with no vagina or one developed in its lower part only. A sound in the bladder can be brought close to the finger in the rectum. Bimanual palpation through the rectum and the abdominal walls shows hæmatocolpos, hæmatometra, and hæmatosalpinx.

The TREATMENT in cases where the defect is merely an imperforate hymen is simple—a crucial incision, after slow removal of the retained fluids through a trocar or small incision. If the defect is more extensive, the areolar tissue between the bladder and rectum should be carefully incised and the dissection be carried deep enough to open the hæmatocolpos. If possible, the raw surfaces of the dissection should be covered by drawing their edges together and suturing them, or by the use of grafts of mucous membrane or flaps from the labia minora. If none of these plans are possible, glass plugs should be inserted and retained until epidermization has occurred from the periphery.

When the entire vagina or the main part of it is lacking, no attempt to make a vagina should be made. The patient should be castrated and the retained fluid aspirated after the abdomen is open. Rectal puncture of the hæmatometra is too dangerous, because of the liability of infection from the rectum.

Practically, no malformation of the uterus requiring surgical care occurs, except those cases of dysmenorrhœa due to *narrowness of the cervical canal.* These are easily treated by dilatation, either with or without previous incision of the cervix. The uterine cavity is usually curetted at the same time.

The Vulva.

Inflammatory processes about the vulva are common, and are due to widely varying causes—gonococci, pus-cocci, irritants from the urine, especially sugar, oxyuris, oïdium albicans, and other parasites.

The SYMPTOMS vary in intensity with the severity of the process. Local pain, sometimes some of the other constitutional disturbances which often accompany local infective processes, discharge, often purulent or fetid, inguinal adenitis, are usually present. There may be added the symptoms of vaginitis, endometritis, salpingitis, or even pelvic peritonitis, which in some cases, especially those due to gonorrhœa, occur by extension. Dysuria may appear, due to the extension to the urethral mucous membrane. In the more chronic cases, especially those due to diabetes, the process is essentially an eczema, and its symptoms are such as occur with eczema elsewhere.

The recognition of the case is important, as it indicates the form of treatment. The gonorrhœal cases will be readily discovered by microscopical examination of the secretion stained with watery solution of fuchsin or methyl blue. (*Vide* Vol. I. Chap. XI.) Cases due to vaginal fistulæ are readily recognized. Diabetic cases are discovered by an examination of the urine.

Cases due to *infection* are treated by rest in bed, if possible, with frequent local baths and douches of hot antiseptic solution, and any constitutional treatment which the case may require. Cases due to fistulæ are cured by curretting the fistulæ. Eczema should be treated with a zinc ointment or diachylon ointment, with 5 per cent. each of ichthyol and salicylic acid, and at the same time any local or general disturbance should be treated.

Œdema of the vulva occurs sometimes in the course of pregnancy as the result of local circulatory disturbances, and frequently in the course

of anasarca from whatever cause.   Because of the looseness of the tissue
the swelling is often extreme.

TREATMENT must be directed to the cause.   Locally, multiple
incisions may be made if gangrene of the parts threatens or if the swell-
ing be so great as to hinder urination.   Very great care is necessary to
avoid infection, which is favored both by the local and general condi-
tion.

The **glands of Bartholin**, about the size of a bean, situated deeply on
the inner side of the labia majora, with ducts opening about the middle
of the sides of the vulva, are frequently the seat of inflammatory pro-
cess, *oftenest gonorrhœal*.   It is in these glands that the gonococci fre-
quently lodge and lie latent even for a long time.   When the infection
is severe abscesses are liable to develop in the glands.   They cause

Fig. 223.
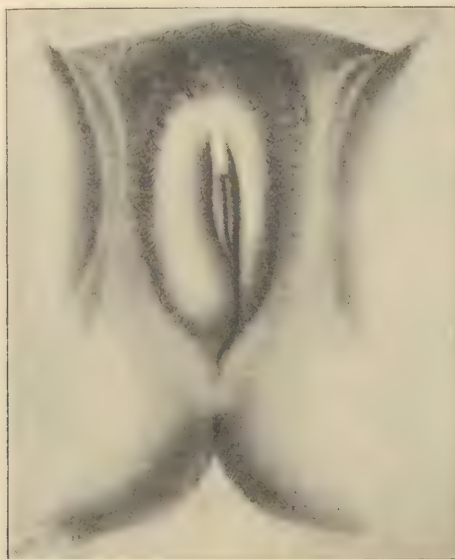
Abscess of gland of Bartholin.

severe local pain, swelling of the labia and neighboring parts, painful
defecation and urination, more or less severe fever, and constitutional
disturbances.   Fluctuation appears later, first on the inner side of the
labium.   If untreated, extensive necrosis is liable to result, and severe
consequences following on healing, because of the cicatricial contractions.
The dangers of septicæmia and pyæmia are present here as with other
abscesses (Fig. 223).

TREATMENT consists of free incision and antiseptic irrigation, fol-
lowed by hot, wet boric- or carbolic-acid dressings.

Cysts of the glands of Bartholin result from inflammatory occlu-
sion of the excretory ducts.   They may be singular or multilocular, vary
in size from a nut to an egg, smooth, ovoid, with viscous contents, color-
less unless mixed with blood.   They cause few symptoms other than dis-
comfort while walking or during copulation, unless the cysts suppurate,

as they not infrequently do, when the symptoms of an abscess appear. Hernia into the labium must not be mistaken for a cyst.

The best TREATMENT is complete removal of the cyst by dissection. Pozzi first removes the contents of the cyst through a trocar, and after irrigation fills the cavity with paraffin of a low melting-point. After hardening the paraffin by cold he dissects out the sac.

A variety of tumors occur about the vulva. *Varicose veins* complicate pregnancy rather frequently, and may on rupture cause serious, even fatal, hemorrhage. Subcutaneous rupture of such a varix may occur, and the resulting hæmatoma be large enough to be an obstacle to

FIG. 224.
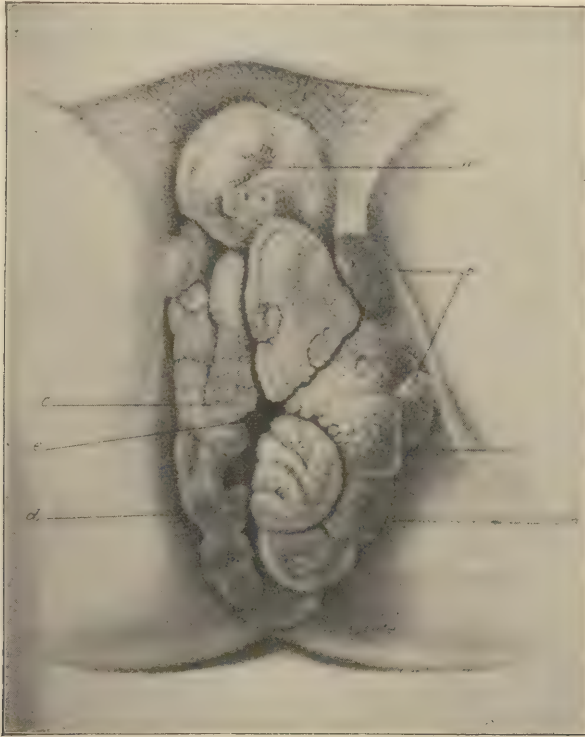
Condylomata of the vulva.

delivery. The varicose veins should be treated by compression combined with an abdominal supporter. If an hæmatoma develop, it should be left alone if small, but if large, because of the great danger of its becoming infected, it should be incised and the bleeding vessel found and tied if possible. If this cannot be done, the hemorrhage should be controlled by a tampon of iodoform gauze. The most careful asepsis is necessary.

Condylomata due to gonorrhœa are common. They are cauliflower-like excrescences on the skin and mucous membrane, pale red or wine color, and often very large. There is an abundant foul discharge, often hemorrhagic (Fig. 224). Pain may be severe.

TREATMENT consists of removal, under cocaine, with the scissors, followed by cauterization of the base. After-treatment is frequent hot antiseptic sitz-baths.

Epithelioma of the vulva is rare. It develops oftenest from the groove between the greater and lesser labia, next frequently from the clitoris and meatus. It extends rapidly to the inguinal lymph-nodes.

The SYMPTOMS are minimal at first, but later, when the carcinoma has attained some size, the pain becomes severe, the secretion abundant, and bladder and rectum disturbances appear as the result of extension to these organs. Whenever the diagnosis is doubtful a microscopical examination of a bit of the tissue should be made. The only curative treatment is early and complete removal, but the prospects of permanent recovery are poor. Palliative treatment consists in the use of the curette or actual cautery in order to lessen the secretion, and local antiseptic dressings and baths. Morphine *ad libitum* for the pain should be used.

Fibromata, myo-fibromata, lipomata, neuromata, and other tumors occur about the vulva, but they are rare. Their SYMPTOMS are due to their size and location, and may be severe enough to necessitate removal.

THE PERINEUM.

Laceration of the perineum occurs most frequently during labor. Sometimes it is due to the removal *per vaginam,* either by operation or the process of nature, of large uterine tumors, especially submucous myo-fibromata. Rarely the laceration is due to direct trauma. Laceration during parturition is favored by any condition which renders the perineum less elastic. These are particularly advanced age—*i. e.* past thirty years at the time of the first delivery—and chronic vaginal and perivaginal inflammation, most commonly gonorrhoeal or syphilitic. Laceration is favored also by excessive development of the foetal head, its descent in an abnormal position, or its too rapid descent.

The laceration usually starts in the median line or very close to it, at the posterior commissure of the vagina or close to the posterior column, and continues on one or both sides of this. According to the depth of the tear, lacerations are divided into two classes, the incomplete and the complete. In the former class are included *all* cases in which the sphincter ani is not torn through. These cases vary from the almost inevitable laceration of the mucous membrane of the vagina to almost complete division of the anal sphincter. The distance to which these tears pass up the posterior wall of the vagina also varies greatly. The complete lacerations are those in which the sphincter ani is torn through, and usually the tear extends some distance up the anterior wall of the rectum.

Before proceeding to a description of the symptoms and treatment of this condition it would be well to recall somewhat briefly something of the anatomy and function of the perineum. The perineal body is not a mere inert mass of connective tissue, but is a wedge-shaped body consisting of muscles, connective tissue, fat, vessels, and nerves. The muscles entering into its formation are the sphincter ani, constrictor vaginae, transversus perinei, and the levator ani. The most important function of this body is the support of the pelvic organs. When it is destroyed by laceration or rendered incapable of performing its duty because of local or general causes, as senile involution, malnutrition, and the like, more or less extensive downward displacement of the pelvic organs must occur, unless these organs are held in place by pelvic adhesions or their prolapse is prevented by maintaining the recumbent position and leading a life of minimal activity.

The SYMPTOMS do not usually appear until some time has elapsed,

and their severity is not always in direct proportion to the extent of the laceration. A laceration in one woman may cause no especial disturbance, while in another a tear of the same size or smaller can cause unendurable suffering. With the descent of the vagina and uterus there may be a sensation of gaping of the vulva, the feeling as if the pelvic contents were falling out. Later, when the prolapsed parts protrude through the vulva, there is acute pain from the inflammation of mucous membrane caused by trauma of some sort. Incontinence of urine or incomplete evacuation of the bladder lead in time to cystitis. Vesical and rectal tenesmus are common. Although copulation is not obstructed, sterility not infrequently results. When the laceration is complete incontinence of gas and liquid fæces is added. In addition to these local symptoms there is a great variety of reflex disturbances and general impairment of health.

On direct examination the vulvar orifice appears lengthened posteriorly. The site of the laceration is marked by a glistening white scar, which by its contraction has caused a puckering of the bordering parts. Varying with the case there may be cystocele, rectocele, or prolapse of the uterus. In complete cases the vagina and rectum are no longer separated, and at the lower end of the remains of the recto-vaginal septum one often sees the hypertrophied rectal mucous membrane projecting downward like a polyp. The posterior column of the vagina may be isolated by the laceration passing to either side of it.

When a fresh laceration is left to itself, cicatricial bands, irregularly connecting the borders of the tear, are formed. The edges are drawn upward by the levator ani, and the ends of the divided sphincter ani are often marked by slight depressions on either side.

All practitioners are now agreed that in all cases, except where the laceration is very superficial, *the tear should be sutured at once.*

Although cases of spontaneous cure occur—and some authors claim that this may happen even in cases of complete laceration—the chances of recovery are too small and the possible results of delay are too serious to warrant leaving a cure to nature, especially as the primary operation adds no danger at the puerperal period. These lacerations should be treated by exactly the same methods which are used in the treatment of lacerated wounds of other parts of the body. Corresponding parts should be united by sutures which are passed deeply enough to secure union of the deeper parts and in sufficient numbers to secure accurate approximation. This procedure is often difficult because of the swollen, œdematous condition of the parts, the abundant hemorrhage, and the exhausted and excited condition of the patient.

The less extensive lacerations will require skin sutures only. When more extensive a line of sutures must be carried up to the vagina, and in complete cases rectal sutures are necessary. It must never be forgotten that the purpose of the operation is the *union of the deeper and muscular parts* rather than of the skin and mucous membrane.

The *suture material* varies according to the individual preferences of the operator, but probably silkworm gut is more generally used than any other material, and it always proves most satisfactory.

The *after-treatment* consists in the careful protection of the wound surface from urine by the use of the catheter. After a few days voluntary urination may be allowed, and the parts afterward carefully washed with antiseptic solution. The vulva and perineum should be

kept covered with moist antiseptic dressing. The bowels should be kept free by laxatives when necessary. The patient should remain in bed for at least two weeks, and throughout the entire time the thighs should be tied together.

A large number of operations have been devised for the late treatment of lacerations of the perineum, but the purpose of all is the same and the principles underlying them are similar.

Although the operations for the complete and the incomplete lacerations are essentially the same, it is customary and convenient to describe them separately.

OPERATIONS FOR INCOMPLETE LACERATIONS.

Before the operation the patient should be given mild laxatives for several days until the bowels are free from all hard fæces. At the same time care must be taken to avoid hypercatharsis. The vagina should be douched daily for several days.

The patient, after being anæsthetized, should be placed in the lithotomy position before a window or strong light. After the usual antiseptic preparation of the parts, two triangular areas are denuded by

FIG. 225.
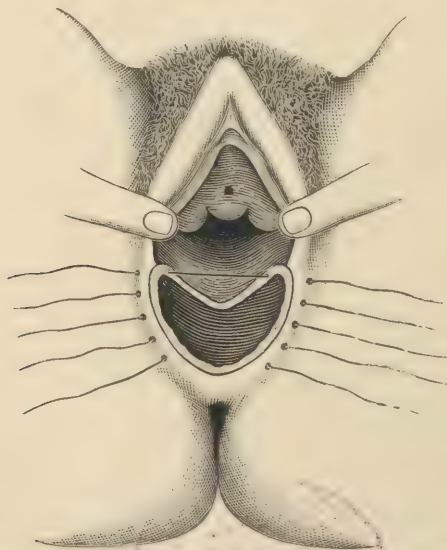
Lacerated perineum : surfaces denuded and stitches in position (Thomas and Mundé).

the scalpel or scissors, the surface to be denuded being held tense by forceps or threads. The base line of the triangles lies in the median line and extends from the cutaneous margin to the highest point of the bulging of the rectum. The third angle of the triangle is on the inner side of the great labium, about midway between the anus and the meatus. After these two triangles are denuded of the cicatricial tissue which covers them, the hemorrhage is checked by ligatures if necessary, though it is rarely that they are demanded. The sutures are then passed from

points on one side of the median line to the corresponding points on the other side. The sutures must be passed deeply, and care must be taken to avoid passing the needles into the rectum (Fig. 225). The sutures near the rectum are entirely buried, while those uniting the antero-lateral parts of the triangle are exposed in the median line of the vagina. The sutures should be passed with a straight or curved round needle, entered about a quarter of an inch from the border of the denuded surface, and the sutures should be about a third of an inch distant from each other. After the sutures are tied the parts are cleansed and dusted with an antiseptic powder. The *after-treatment* is the same as with the primary operations.

Emmet's Operation.—The area lying between the posterior commissure, the lowest caruncle of the hymen, and the crest of the rectocele is denuded on either side. The anterior and the lateral borders of the denuded area on each side are united by sutures which are passed deeply. The remaining

Fig. 227.
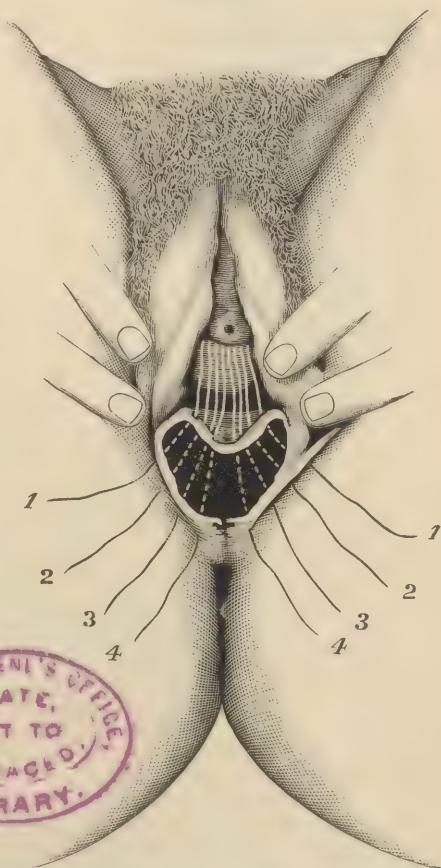
Fig. 226.

Emmet's new operation for lacerated perineum.

Emmet's operation for lacerated perineum.

portions of the lateral borders are united to each other. The resulting line of union is Y-shaped, the stem being in the median line, and an arm passing up each side into the vagina (Figs. 226 and 227).

Tait's (or the Flap-splitting) Operation.—The posterior wall of the vagina is stretched forward by a rectal tampon and by the fingers in the rectum. The labia are drawn tense by the assistants and sharp-pointed scissors are inserted in the median line, midway between the posterior commissure and the anus. The recto-vaginal septum is split to the depth of one-half or three-quarters of an inch, and for the same distance on either side of the median line. From the ends of this incision another, about one-half an inch deep, is carried up on each side to the anterior border of the cicatrix. The anterior flap is drawn forward by

Fig. 228.

Fig. 229.

Flap-splitting operation for incomplete laceration of the perineum.

Flap-splitting operation for lacerated perineum: appearance of wound and introduction of sutures for both varieties (Thomas and Mundé).
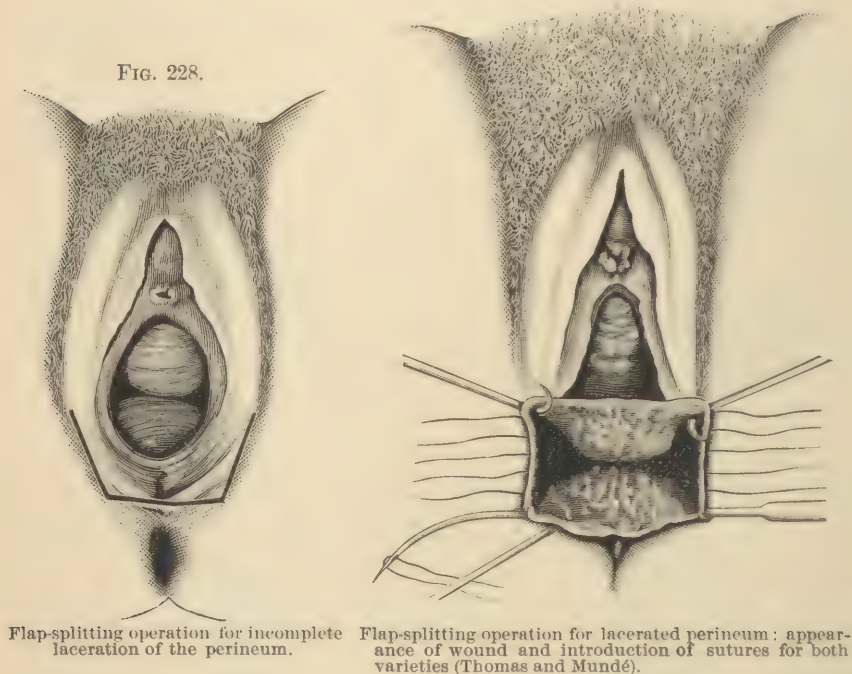
tenacula, and the resulting rectangular surface is closed by sutures passed from one side to corresponding points on the other (Figs. 228 and 229).

Doleris' operation for incomplete laceration of the perineum varies a little from the flap-splitting operations so commonly in vogue in one important particular. The upper stitches traverse the under surface of the flap, thus drawing the latter completely into the wound and making it constitute a portion of the body of the perineum.

Fig. 230 represents the line of initial incision made with the knife or scissors.

Fig. 231 shows the dissection of the mucous-membrane surface from the posterior vaginal wall by means of the fingers.

Fig. 232 indicates the line of introduction of the sutures, a portion of which are carried through the flap.

Fig. 233 presents the lower half of the wound closed.

Fig. 234 shows the resection of the redundant vaginal mucous membrane.

Fig. 235 represents the completed operation.

FIG. 230.
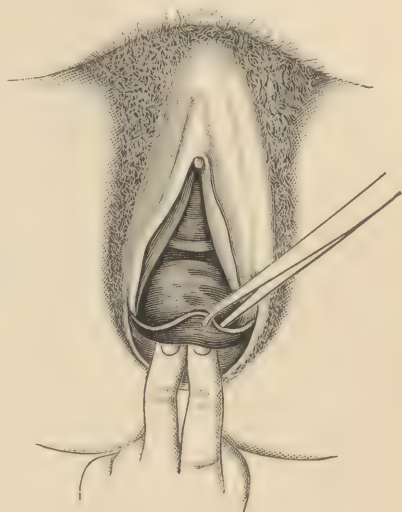
FIG. 231.

Doleris' perineorrhaphy, *a*.

Doleris' perineorrhaphy, *b*.

Duke's Method of Perineorrhaphy.—The most recent operation for closing an incomplete laceration of the perineum is that offered by

FIG. 232.
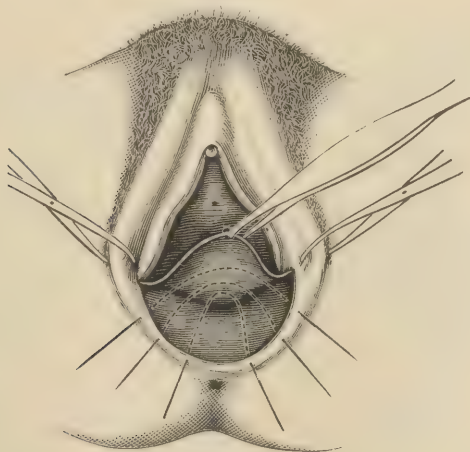
Doleris' perineorrhaphy, *c*

Alexander Duke of Dublin, who sent the following description and illustration to the writer in 1892:

"I wish," he said, "to bring before the notice of my gynecological brethren an operation I have designed for the restoration of a lacerated

perineum, easy of performance, and which will, when properly executed, form a good perineal floor and, I might almost say, practically a perineal body. The patient, having been prepared by the usual pre-

Fig. 233.
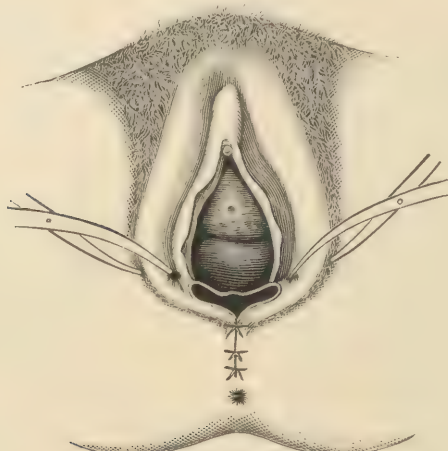
Doleris' perineorrhaphy, *d.*

liminary steps required for the old operation, when under the influence of an anæsthetic is placed in the lithotomy position ; the left index finger being introduced almost its entire length into the rectum, a long straight double-edged bistoury is made to pierce the tissues in front of the anus

Fig. 234.   Fig. 235.

Doleris' perineorrhaphy, *e.*

Doleris' perineorrhaphy, *f.*

at right angles to the vulva, and, guided by the finger in the rectum, is made to penetrate the septum for two and a half inches upward, the incision being enlarged laterally to two inches as the knife is withdrawn.

"The patient is then turned on her side, and on the points of the incision being pressed together a lozenge-shaped opening will be seen; and when all sutures required have been introduced and are properly adjusted and approximated the two cut surfaces are brought into direct apposition. The sutures are introduced by a strong cycle-shaped needle, with eye near the point, mounted on a handle, strong silver wire being the suture preferred.

"The needle is introduced at the edge of the incision, and, guided by a finger in the rectum, is made to travel under the cut surface to its full depth above, describing the arc of a circle; and on the point of the needle appearing *directly opposite* it is threaded with suture and drawn through. On the ends of this being drawn together with the fingers a good idea can be formed of how many additional stitches may be required. When all considered necessary have been inserted and approximated, being first passed through a perforation in leaden plate (see illustration), a finger of each hand passed into the rectum and vagina will at once recognize the gain in thickness of septum, the external tissue being pushed fully an inch forward from the anus and forming a thick and solid perineal body.

FIG. 236.

"The incision being a deep one, on union taking place between the raw surfaces a considerable amount of support must be afforded in cases where a pessary is required or where there is much tendency to prolapse of uterus or vaginal walls. My experience of the operation has satisfied me with the results, and, there being *no loss of tissue whatever*, should the operation fail it cannot add any difficulty to a subsequent one.

"Even should the perineum be lacerated to the verge of the anus, what I describe can be done. I find that leaving the sutures for ten days is generally sufficient; but if I am in doubt as to the union being strong, I cut the wire, but leave it *in situ* for a day or two longer, thus affording some support and relieving the strain on the edges of the suture-holes; and I also support the parts by long strips of adhesive plaster carried from hip to hip over new perineum. The wire should be stout and not too tightly twisted.

"The advantages of my plan of operation are briefly these:

Duke's operation, showing various stages.

"1. The simplest of performances as yet proposed; no danger of hemorrhage, the surfaces when dry being brought together.

"2. No danger of sepsis, as the incision is not open for the admission of any discharge from either vagina or rectum during the healing process.

"3. No loss of tissue, and consequently no harm done should the operation fail" (Fig. 236).

The outlines of the denudations made in the operations suggested by Bischoff, Hegar, and Fritsch are presented in Fig. 237. The underlying principle of each is apparent.

Operations for Complete Laceration of the Perineum.

Operations for complete lacerations are more difficult on account of the often considerable deformity resulting from the contraction of the scar-tissue, and because of the ready hemorrhage from the rectal mucous

Fig. 237.
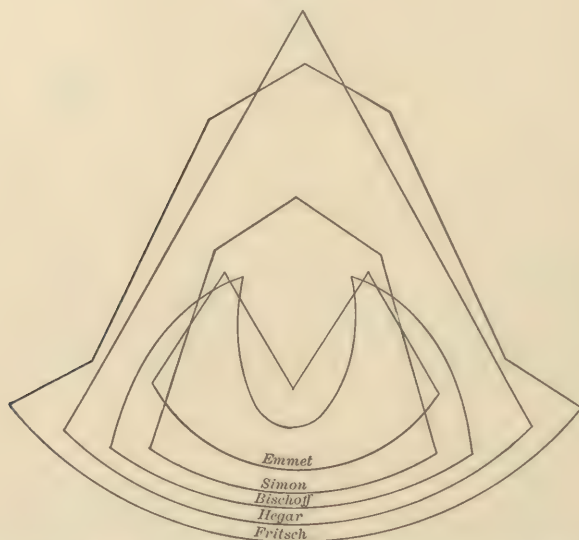
Scheme of the outline of operations proposed by Emmet, Simon, Bischoff, Hegar, and Fritsch (Kelly).

membrane. Moreover, unless the preparation of the patient has been most careful, an escape of fæces is apt to occur during the operation.

Simon's Operation.—The area of denudation is a symmetrical, somewhat butterfly-shaped figure. The following points are seized with the forceps: A point on the inner side of the great labium about its middle, This corresponds to the anterior tip of the new-formed perineum. A second point is near the border of the anus, corresponding to the end of the divided sphincter ani. A third point is the tip of the remaining portion of the recto-vaginal septum. Lines drawn between these points determine the lateral and the posterior borders of the denudation.

The denudation is carried upward on the vaginal side of the septum to the highest point reached by the tear. From this point a curved line, with its concavity forward, is carried to the point on the labium majus. The resulting area of denudation should closely resemble the raw surface at the time of the laceration. The second step in the operation is the suturing, which may be done in several ways. Simon passed three sets of sutures—the vaginal, tied in the vagina and uniting, as do the others, symmetrical points; the rectal set is tied in the rectum, and then the skin sutures are passed. The sutures must be passed deeply, but care

must be taken in passing the vaginal sutures to avoid making a recto-vaginal fistula. Martin recommends passing the sutures in one, two, or three layers, using a continuous catgut suture.

Emmet's Operation.—The area of denudation is similar to Simon's. The peculiarity of the operation is the method of passing the sutures. Using a handled needle, the first suture is entered about one-third of an inch external and posterior to the posterior margin of the denudation, and carried through the lower part of the remains of the recto-vaginal septum to a point exactly opposite. The purpose of this suture is to bring together the ends of the divided sphincter ani muscle. When

Fig. 238.
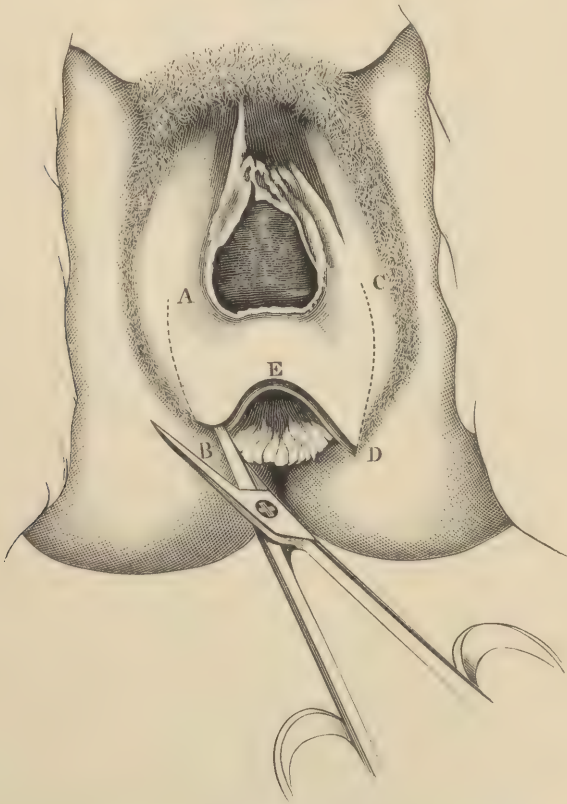
Tait's operation for complete laceration of the perineum.

tied it acts as a purse-string suture, and by thus closing the defect in the septum converts the complete into an incomplete laceration. The other sutures are passed as in the operation for incomplete laceration.

Tait's operation for complete laceration differs but little from that for the incomplete. The recto-vaginal septum is split to the depth of about half an inch. At each end of this incision others are made forward to the anterior border of the cicatrix, and backward just beyond the ends of the divided sphincter ani muscle. These three incisions

resemble somewhat a capital **H**.   The vaginal flap is turned forward by tenacula, the rectal flap backward, exposing in this way a quadrangular bleeding surface.   Sutures are passed from side to side ; the one nearest the rectum is passed first, taking care to pass it deeply enough to include the ends of the sphincter muscle (Figs. 238–241).

Fig. 239.
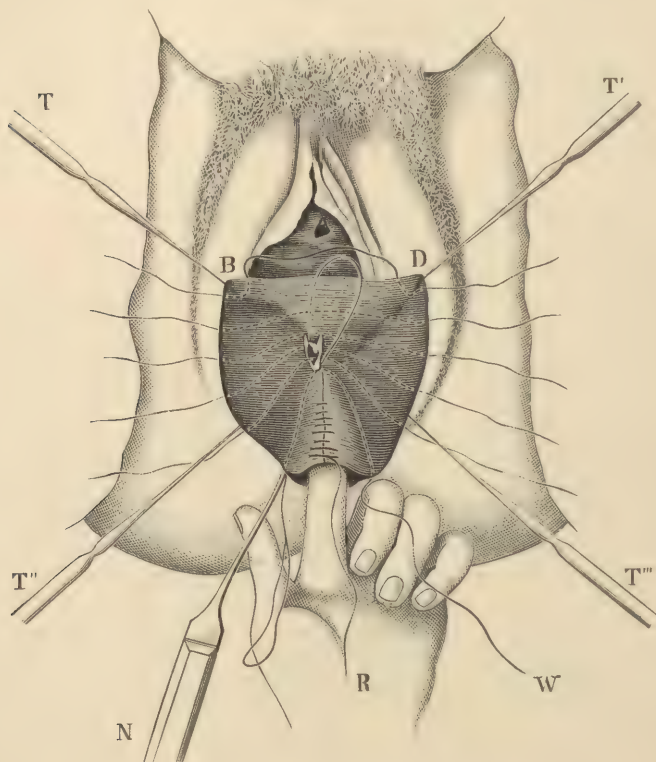
Tait's operation for complete laceration of the perineum.

The after-treatment of the patient is of great importance. The field of the operation should be carefully cleansed, dried thoroughly, dusted with boric acid, and covered with a dry dressing. The wound must be protected from the urine by catheterization. Should the patient pass urine voluntarily, it should be passed under a stream of warm sterilized water. The bowels must be kept confined for three or four days, and then moved by a gentle laxative, aided, if need be, by a warm enema, which must be given with care by the physician or nurse, who thoroughly understands the reasons for and necessity of great care. A movement of the bowels once in three days is desirable, and if they tend to move more frequently a little opium should be given. If the patient is troubled with gas in the intestines, a soft rectal tube may be passed carefully several times daily. The diet should be nourishing, and for the first week, at least, fluid. Another method of managing the bowels is to give a daily saline laxative. This line of treatment is especially commendable, for obvious reasons, in cases of complete laceration of the perineum. All foods which contain much waste or which readily ferment must be forbidden. The use of an intestinal antiseptic, such as salol, is to be recommended. If the temperature rise, the wound has probably become infected. This can easily happen, because of the difficulty of accurate approximation and the exposure of

the wound to the bacteria-loaded fæces. The edges of the wound become red, œdematous, painful, and tender, and, unless the infection can be controlled, union

FIG. 240.
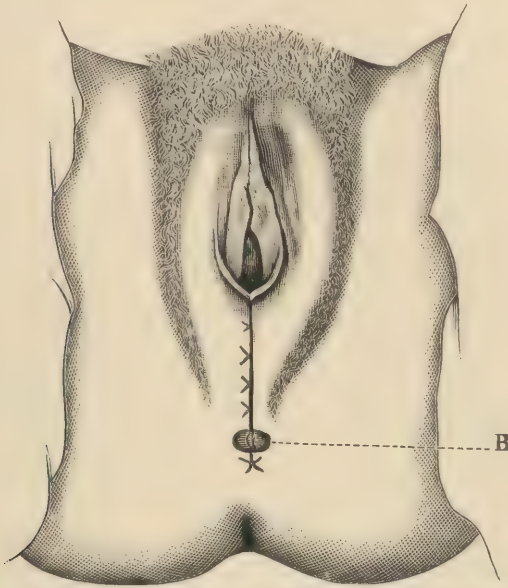
Tait's operation for complete laceration of the perineum.

FIG. 241.
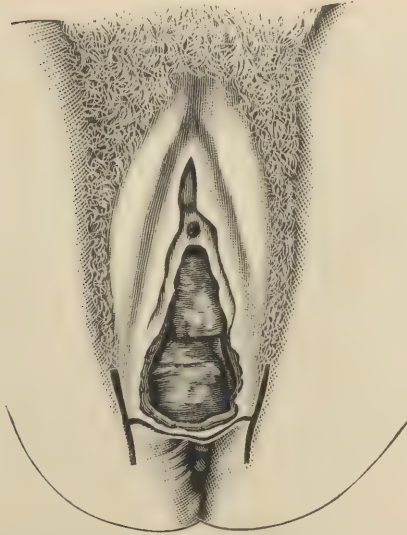
Flap-splitting operation for complete laceration of the perineum.

to a greater or less extent will fail. Sometimes the trouble will end on the removal of one or two of the sutures. If union fail along the cutaneous surface, no serious

results follow, but if the failure is in the recto-vaginal septum, a more or less exten-
sive fistula results and a secondary operation is necessary to close it. Simple
cauterization is sufficient if the fistula is small, but if large the edges must be
freshened and closed by sutures. A secondary operation should not be undertaken
sooner than four weeks after the first one.

The *sutures may be removed* on the tenth or twelfth day. The patient should
not begin to walk sooner than eight or ten weeks after operation, and copulation
must be forbidden for at least six months.

The Uterus.

Prolapse of the uterus and vagina is usually the result of injuries
to the pelvic floor occurring during labor, laceration of the perineum,
and stripping of the vagina from its relation to the surrounding parts;
but in many cases it seems that this factor does not occur for years after
delivery. Such accessory factors are—too early return to work after
delivery, severe manual labor, malnutrition from whatever cause, and
senility. Rarely cases of prolapse occur in young virgins after some
violent effort. Some congenital weakness of the supports of the vagina
and uterus is supposed to exist in these cases, and this supposition seems
to be more probable because the families of such patients often show a
large number of hernias. Occasionally senility causes prolapse in women
who have never borne children. Retroflexion, retroversion, and hyper-
trophy of the uterus predispose to prolapse.

The *prolapse* may affect only a small portion of the vaginal wall or involve the
entire vagina and uterus. Usually the prolapse affects first the lower portion of the
anterior wall, and shortly afterward the posterior wall is similarly affected. The
uterus depends into the concavity of the sacrum, and its long axis comes to lie
nearly in the long axis of the vagina. When the bladder descends with the ante-
rior wall, we have *cystocele.* When the rectum comes down, *rectocele* is formed. As
the vaginal prolapse increases the uterus descends lower and lower until its neck
appears outside the vulva. In other cases the mechanism is different. The pro-
lapse affects the lowest part of the anterior wall first, then the highest part, then
the uterus, and lastly the posterior wall from above downward. In other cases the
process is exactly reversed. In rare cases the prolapse affects only the anterior or
posterior fornix of the vagina, and an anterior or posterior enterocele results.
Sometimes the uterus descends, pulling with it the vaginal walls from above down-
ward.

The uterus is rarely unaltered in shape, consistency, and weight. The cervix
is usually elongated and hypertrophied. The body is enlarged. The cervical and
corporeal mucous membrane is inflamed. The relations of the bladder, uterus,
and rectum are changed in many ways and to many degrees. The peritoneum
follows the uterus in its descent.

The SYMPTOMS vary in kind and intensity. The patients complain
of bearing-down sensations and of the feeling as if the viscera were fall-
ing out. They easily tire on walking, and their gait is often peculiar.
The symptoms of *endometritis* are often present. Function of the bladder
and rectum is altered. If the cystocele is marked, cystitis from incom-
plete evacuation of the bladder is frequent. Pain from erosions and
inflammation of the prolapsed mucous membrane may be severe.

The result of local examination varies with the case. In the lesser
degrees the vaginal mucous membrane appears only when the patient
bears down, the anterior wall usually appearing first. In the complete
cases the hypertrophied cervix lies behind the prolapsed anterior vaginal
wall. The mucous membrane is variously altered. There may be

inflammation or ulceration, or the character of the mucous membrane can gradually change until it resembles skin.

TREATMENT consists in general tonic with rest and massage. These, combined with a proper pessary or tampon, with astringent douches, will be sufficient in many cases.

The *operations* for cure for this condition are of three sorts—those which *improve the supports* of the uterus lying below it, those which *shorten the uterine ligaments* or add other supports to them, and those which *remove the uterus.* The first class of operations includes *perineorrhaphy* and *colporrhaphy,* many variations of which have been described. The perineorrhaphy is described in the section treating of lacerations of the perineum. The *colporrhaphy* has for its purpose the narrowing of the vaginal canal. It may be made separately or in connection with a perineorrhaphy. The different operations vary in details only.

An area is denuded on the posterior wall varying in shape from triangular to oval, and in size with the degree of the prolapse. Symmetrical points on each side of the median line are sutured. Care must be taken to secure accurate approximation, using one or more layers of sutures as may be necessary. Martin denudes two long areas on each side of the median line, and closes each denudation by a continuous suture in layers. Neugebauer denudes two areas similar in shape and size, one on the anterior and one on the posterior wall, and unites them to each other, making a band across the vagina.

Operations of the second class include the *Alexander operation*—*i. e.* shortening the round ligaments and *ventro-fixation.* These operations are rarely sufficient in themselves, but do well in combination with plastic operations on the vagina and perineum.

FIG. 242.
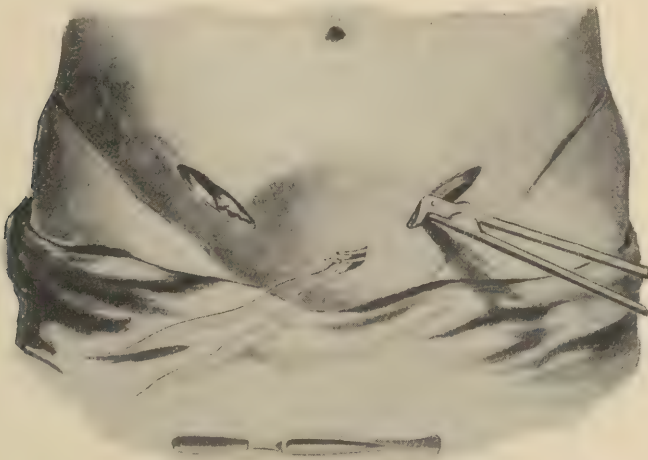
Alexander's operation (*a*) (after Cleveland).

Alexander's operation is briefly as follows: Incisions are made on either side, exposing the external inguinal ring. The round ligament is next isolated. After replacing the uterus by the sound or by

bimanual manipulation the ligaments are drawn outward about three inches. A suture is passed through the upper end of the external pil-

Fig. 243.

Alexander's operation (b) (after Cleveland).

lar of the ring, then through the ligament, and then through the internal pillar and tied. The lower portion of the ligament is treated by Clement Cleveland of New York in a way original with him. It offers the best results known to the writer, and he thus describes it.

"At this point I practise a modification of my own, which saves an inch or more of the ligament and, as it seems to me, secures a better prospect of success.

Fig. 244.
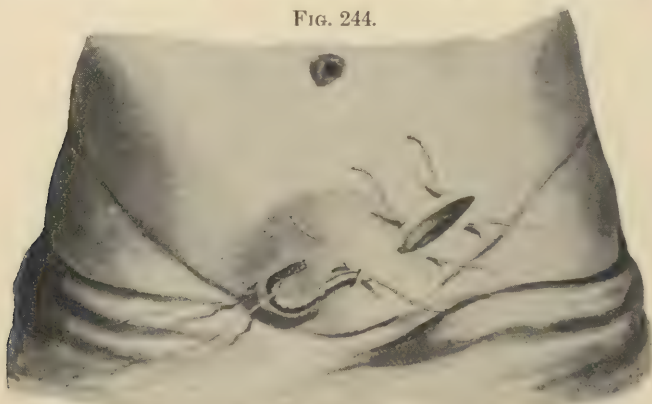
Alexander's operation (c) (after Cleveland).

A ligature-carrier (Fig. 243), made sharp and delicate for the purpose, is passed at the lower end of the incision under the fascia and out on the mons, at a point an inch or more below the pubic spine (Fig. 242). The carrier is then opened a little in order to make the canal sufficiently large for the passage of the ligament and to stretch the fascia slightly. A loop of silkworm gut or other material is then placed in the grasp of the carrier, and the instrument is drawn back with this

loop into the incision (Fig. 243). A loop of the end of the ligament is then placed in the loop of silkworm gut (Fig. 243), and the latter drawn back with the ligature through the small opening in the mons (Fig. 244). While an assistant holds the ends of the ligament quite taut the sutures in the incision are then tied, and, lastly, the suture is passed through the integument and ligament at the point of exit of the latter on the mons, then tied, and the excess of ligament is cut away (Fig. 245). The same process is repeated on the other side. If the operation have

Fig. 245.
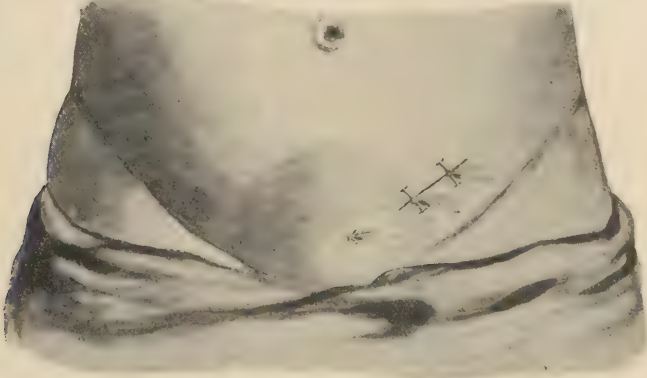
Alexander's operation (*d*) (after Cleveland).

taken a good deal of time or there have been rough handling of the tissues and ligament, a few strands of silkworm gut are placed under the ligaments in the canal as drainage. A dressing of gauze wet with a solution of 1 : 3000 bichloride is placed over the wounds, with pads of sterilized gauze and cotton above it, all being secured by a double spica bandage firmly applied. The patient is kept in bed for three weeks. Liquid food is given for the first few days, and after that, if no unpleasant symptoms have appeared, as generous a diet as is allowable to a patient kept in bed. The bowels are moved every other day."

Ventro-fixation consists in the median incision of the abdominal wall close to the pubes. The uterus is freed from adhesions and brought forward and upward. Sutures are then passed, either through the entire thickness of the abdominal wall, and through the serous and outer muscular coat of the uterus, or they may be passed in such a way that they are buried after closure of the skin incision. Before tying the sutures the parts of the uterine and parietal peritoneum which will come in contact should be scraped, in order to hasten the formation of adhesions. After leaving her bed the patient should wear a Hodge pessary for some time.

Another method of surgical treatment, found satisfactory in most cases, is a combination of amputation of the cervix and an extensive anterior colporrhaphy. These operations are usually followed by a speedy uterine involution with its diminished weight, and by a substitution of anteversion of the uterus for retroversion.

LACERATION OF THE CERVIX.

Laceration of the cervix is almost always due to the passage through the cervix of a fully-developed fœtus, though it has been known to occur with abortions at the third or fourth month. According to statistics by Mundé, it occurs once in about every four deliveries, and

usually with the first child, but in more than half of the cases the laceration never causes any symptoms. The tear is usually bilateral, often unilateral, and then more frequently left than right. Sometimes it is multiple or stellate. (Plates XI. and XII.)

In those cases in which the laceration of the cervix causes symptoms there is subinvolution of the cervix and uterus, hyperæmia of the uterine adnexa and ligaments, predisposing all these contiguous parts to inflammation and leading eventually to hyperplastic changes. The lips of the cervix roll outward, exposing the endocervical mucous membrane to trauma and the irritating action of the vaginal secretions, and in this way causing a chronic cervical catarrh. The scar-tissue which is formed obstructs the ducts of the glands, causing them to become cystic. The papillæ become hypertrophied, and may be so much so as to resemble carcinoma. There is a profuse secretion of thick, glairy mucus, often tinged with blood from the granular surface, which bleeds on the slightest trauma. The catarrh often extends upward into the cavity of the uterus, where the endometritis often assumes a fungoid character.

The SYMPTOMS vary greatly in intensity, and may be entirely lacking even with deep lacerations. The local symptoms are dull pain in the back, bearing-down sensation, pain in the ovarian regions, reflex pains in the thighs and back, leucorrhœa, menorrhagia and the consequences, sterility and habitual miscarriages. The general symptoms increase the longer the laceration exists, and take the form of a simple anæmia and various neurotic disturbances. The relation of cause and effect between the laceration of the cervix and the general symptoms described by Emmet is by no means clear.

The DIAGNOSIS of laceration of the cervix is made by digital examination of the cervix and by inspection through the speculum. Occasionally there will be a question as to whether a given case is simply an excessive development of the glands and papillæ of the mucous membrane or an epithelioma. The question can be settled only by the microscope.

OPERATION.—The patient, under anæsthesia—or without it if there is any contraindication, for this operation is not especially painful—is put in Sims' or the lithotomy position. The cervix is drawn downward by bullet forceps or by sutures passed through the lips. The lower lip is denuded first from its tip to the angle, taking care to remove all of the scar-tissue. A narrow strip of mucous membrane about a quarter of an inch wide must be left in the median line to form the lining membrane of the future cervical canal. The anterior lip is treated in the same way, taking care to make the denudation on the anterior and posterior lips exactly alike in shape and size. If the hemorrhage be troublesome, it may be checked by hot water or by a suture passed through the cervix above the angle of the tear. The sutures are passed through the entire thickness of both lips, the one nearest the angle being passed first. From two to four sutures on each side are usually required. After tying the suture a douche is given and the patient is put to bed, where she is kept for at least one week. If any discharge appear, an antiseptic douche should be given once or twice daily. The sutures are left in place two or three weeks.

Myo-fibromata of the Uterus.

The most common of the tumors of the uterus is the so-called fibroid, or, more properly, myo-fibroma. It consists of bundles of non-striated

PLATE XI.

Granular Erosion of Cervix.
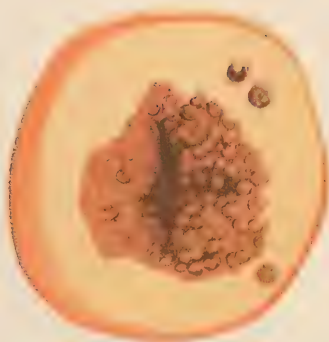
Cystic Degeneration after Laceration.
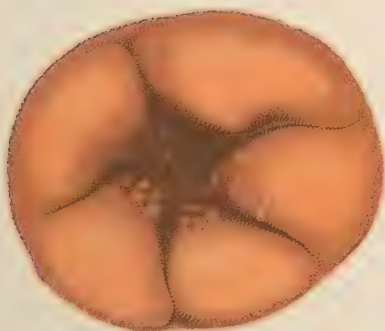
Deep Stellate Laceration.
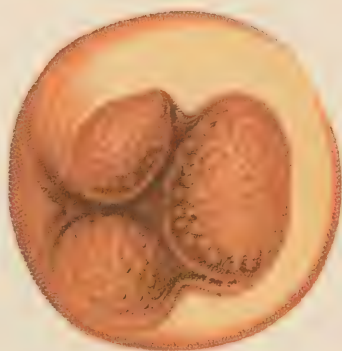
Stellate Laceration with Ectropium
and Cystic Disease.
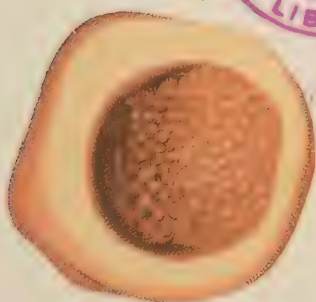
Crescentic Laceration with
Erosion of one Lip.
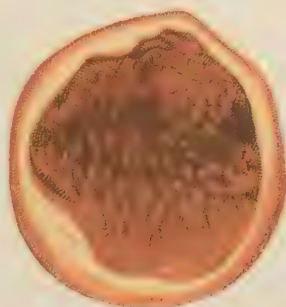
Deep Destructive Laceration
up to Inner Os.

LACERATIONS OF CERVIX.

PLATE XII.

Unilateral Laceration beyond
Vaginal Insertion.

Stellate Fissure with Erosion.

Double Laceration with Erosion.

Double Laceration beyond
Vaginal Junction.

Bilateral Laceration, Great Erosion and
Cicatricial Induration.

Cystic Disease Implanted on Lacerated
Cervix, Simulating Cauliflower Growth.

LACERATIONS OF CERVIX.

muscles arranged in various directions, together with a varying amount of fibrous tissue, which is arranged mostly about the larger vessels, but also between the muscle-bundles. The tumors are, in a way, circumscribed hypertrophy of the uterine wall. (*Vide* p. 417, Vol. I.)

The more abundant the fibrous tissue, the harder the tumor. The smaller tumors show a concentric arrangement about a single centre, while the larger tumors show several centres. The vascular supply is often abundant; in fact, the number of the vessels may be so great that the tumor can be spoken of as a teleangeiectatic or cavernous fibroma. The number of the tumors varies up to forty or fifty, and the size to even 172 pounds (78 kilos, Orth). The different tumors in the same uterus also vary in size. The most common site is the posterior wall, then the anterior, the fundus, and lastly the cervix. The cervical fibromyomata make up about 8 per cent. of the total, and are especially apt to form polypi.

The fibro-myomata developing from the body of the uterus are classified according to their point of origin into three classes—the *interstitial*, developing in the thickness of the wall, 65 per cent.; the *submucous*, 10 per cent.; and the *subserous*, 25 per cent. The *interstitial* tumors, because they can receive vessels from all sides, grow more rapidly and to greater size than the other forms. Their connection with the surrounding parts is so loose that they can usually be shelled out of their capsule very easily. The surface is smooth or lobulated according as they develop from one or several centres.

The *submucous* forms occur oftenest at the fundus, and project to a greater or less extent into the cavity of the uterus. They may be sessile or pedunculated. The latter may be entirely detached from the wall and be expelled spontaneously. They are usually small, but they may reach the size of a child's head. They are never lobulated, but their form may be much altered by pressure.

The *subserous* forms are sessile or pedunculated. The length and thickness of the pedicle vary, and, like the pedicle of the submucous fibroid, may be divided and the tumor be detached from its point of origin. In exceptional cases, where there have been no adhesions formed previous to division of the pedicle, the tumor becomes a free body in the abdominal cavity. Usually, however, there are numerous adhesions, so that the tumor is attached to some other abdominal organ—a condition which may cause curious diagnostic difficulties. These adhesions are also important because of the complications which they may cause, such as internal strangulation of the intestines, and because by increasing the blood-supply to the tumor they hasten its growth.

Fibro-myomata are liable to a *variety of secondary changes. Fatty degeneration*, either localized or diffuse, is common, and can bring about a softening of the entire tumor into a puriform mass or lead to the formation of irregular cavities filled with a similar fluid. *Calcification* occurs most frequently in the subserous tumors of small size, though it may occur in tumors as large as an adult's head. The calcification may be diffuse, but it is usually in the form of irregular coral-like deposits. Sometimes only the peripheral parts are changed. *Suppuration* and *gangrene* occur, the latter especially in the polypoid form. *Œdema* is frequent, and affects especially the connective tissue, converting it into a transparent, jelly-like mass. Important, but fortunately rare, is the change in the character of the tumor from benignant myo-fibroma to malignant, rapidly-growing *sarcoma*. The majority of the so-called fibro-cystomata of the uterus are the ordinary fibro-myomata altered by circulatory disturbances. Clear serous fluid can collect in interstices of the tissue or in lymph-vessels, forming even large cysts. These two forms may be distinguished from each other by the fact that the distended lymph-vessels still show their endothelial lining. Very rarely cysts lined with cylindrical epithelium are formed in combination with fibroma. They are either detached portions of the glands of the mucous membrane of the uterus or are congenital epithelial dystopiæ.

Very little can be said in regard to the ETIOLOGY of these tumors.

They are never formed before puberty. They are most common between thirty and forty years; more frequent in negroes than in whites. Nulliparous women are more subject to them than others. Chronic endometritis and menstrual disorders favor their development.

The SYMPTOMS are more influenced by the position of the tumor than by its size and numbers. Even large tumors may develop from the fundus without causing any symptoms, while small tumors situated low down on the anterior or posterior wall of the body of the uterus or in the cervix, especially when they develop into the broad ligaments, may cause serious symptoms because of the pressure which they exert upon the bladder, rectum, and the large vessels and nerves of the pelvis. Leucorrhœa, menorrhagia, and dysmenorrhœa are common. The uterine hemorrhages are often severe, and frequent enough to greatly debilitate the patient, and may be so abundant as to cause death by exsanguination. Pain is frequent and varies in location and intensity. There may be nothing more than a sensation of weight in the pelvis and bearing down, or it may amount to a severe sciatica. Uterine colic, expulsion-pains similar to labor-pains, are common, when the tumor projects greatly into the uterine cavity. Disturbances in urination are common —dysuria, retention, and gradual dilatation of the bladder. In time cystitis develops, and later may lead to an ascending pyelo-nephritis. Pressure may be directly on the ureters leading to hydro-nephrosis on one or both sides. It is probable that many of the deaths which follow operations on uterine fibro-myomata are due to these secondary affections of the urinary tract. Pressure on the rectum causes rectal tenesmus, hemorrhoids, and constipation.

The general health of the patient suffers from the loss of the fluids of the body by hemorrhage and the often profuse discharge; also from the toxæmia resulting from absorption from the urinary and intestinal tracts and from the pain and mental depression.

The DIAGNOSIS of fibro-myomata of the uterus must be made by the physical examination, by vaginal, abdominal, and bimanual palpation. The tumor, unless small or in a very fat woman, is readily palpated, and its connection with the uterus usually readily demonstrated. The uterine sound, which must be carefully passed on account of the danger of its setting up a hemorrhage, shows that the uterine cavity is lengthened often to a very considerable degree.

Differential diagnosis of myo-fibroma from *pregnancy* can usually be made by the common signs of pregnancy—amenorrhœa, the breast changes, etc.—but occasionally these signs fail to give a positive conclusion, and the patient must be watched for the positive signs of pregnancy. Differentiation from *extra-uterine pregnancy* is still more difficult and often impossible. In such a case the rule must be that if there are any reasonable grounds for suspecting extra-uterine pregnancy, laparotomy must be done at once. Tumors due to *pelvic cellulitis* and *hæmatocele* are accompanied by signs of acute inflammation or by a history of such symptoms, and are usually readily distinguished from fibroma, but the differential diagnosis becomes impossible in cases of fibroma in uteri which are adherent and the adhesions the seat of acute inflammatory processes. Examination under ether may clear up the diagnosis in such cases.

Submucous fibroids are easily confused with incomplete *abortions* and *endometritis*. The history may aid in the cases. If not, microscopical examination of bits removed by the curette must decide.

PROGNOSIS as regards life is generally favorable, although the gen-

eral health is often so impaired by the frequent loss of blood that slight ailments, such as bronchial or intestinal catarrh, may prove fatal. The danger of pyelo-nephritis must not be forgotten, and we must remember that cases of large abdominal tumor show signs of cardiac insufficiency due to fatty or interstitial changes in the myocardium. The tumor may become gangrenous along the course of its pedicle or it may suppurate. On the other hand, the tumors often atrophy on cessation of the uterine and ovarian functions.

PALLIATIVE TREATMENT is resorted to in the majority of cases, and especially in those where the symptoms are slight or the patient near the menopause. Many of the symptoms, such as pain, sciatica, consti-pation, vesical irritation, which result either from displacement of the uterus or its enlargement, are relieved by reposition of the uterus to its normal position and its permanent retention by the use of whatever pessary most completely fulfils the requirements. The hemorrhages are treated in various ways—by ergot, hydrastis canadensis, cannabis indica, gallic acid internally, and locally by styptics and tampons. If these means fail, the curette should be used. An intra-uterine electrode with the galvanic current is also used for this purpose.

The CURATIVE TREATMENT is medical, electrical, or surgical.

Ergot given hypodermically or by mouth for many months cures not infre-quently the monolobular variety only. Mineral waters, especially those contain-ing the alkaline iodides and bromides, preparations of arsenic and phosphorus, and hydrastis canadenesis have all been used, and each has, in a certain number of cases, given positive results.

Treatment by *electrolysis* requires currents of 80 to 250 milliampères strength. A large electrode is applied to the abdomen, and the other pole is introduced into the uterine cavity or by puncture through the vagina or abdominal walls directly into the tumor. Each sitting lasts for from three to six minutes, and the sittings must be continued over several months. A certain number of cures are effected in this way.

The **surgical means** used in the cure of fibroids vary greatly with the cases, but the operations may be divided into two classes—the *vaginal* and the *abdominal.* The majority of cases are treated by the former class. Fibroma of the cervix can usually be removed by simple incision of the capsule and enucleation with the finger or dissector. The hemorrhage is usually insignificant, but if severe can be controlled by pressure with a tampon or by the use of hot water. Operations for pedunculated fibroma of the body of the uterus must often be preceded by dilatation of the cervix in order to reach the tumor more easily. This may be done rapidly by Hegar's dilators, with or without bilateral division of the vaginal portion of the cervix with the scissors and of the fibres of the internal os with a bistoury. After dilatation of the cervix the removal of the tumor is usually easy. The tumor is first twisted a few turns about the long axis of the pedicle. After making certain, by examination through the abdominal walls, that the uterus has not been inverted, the pedicle is divided by scissors curved on the flat. The hemorrhage is usually slight, but if severe can be controlled by a tampon or by heat. The uterine cavity is douched with an anti-septic solution, and the cervix, if divided, is sutured as in operations for lacerations of the cervix. The use of the chain and wire écraseur has been largely abandoned, because the danger for which they were

introduced—namely, hemorrhage—has been found to be minimal, and they brought with them dangers greater than the one they sought to avoid. It is quite impossible to perfectly control the amount of tissue included in the loop, and perforation of the uterus has happened several times, even in the hands of experienced operators.

Submucous fibroids, including the interstitial tumors which are close to the mucosa, are treated as follows : The cervix, if not already dilated, must be dilated as described above. The tumor is seized with volsellum forceps; the mucous membrane is incised freely along the line where it is reflected from the uterine wall on the tumor. The tumor is now separated by the fingers, scalpel, or scissors from its capsule, and, with or without previous fragmentation, removed.

The *after-treatment* is the same as already described. The dangers of the operation are hemorrhage ; perforation of the uterine wall, which is not a very serious accident if the operation is done with proper aseptic care ; inversion of the uterus—a favorable rather than an unpardonable occurrence if it is recognized, as it facilitates the enucleation ; and, lastly, septicæmia, which is to be avoided by the ordinary rules of aseptic surgery. In some cases where the tumor is large the capsule is incised, and without effort at enucleation the tumor is removed in pieces by morcellation, controlling the hemorrhage by forceps.

Vaginal hysterectomy is employed in cases where the tumor does not exceed the size of the fist, when the hemorrhage threatens to be rapidly fatal, and when serious compression symptoms develop. In all other cases, where the tumor cannot be removed by any of the operations already described, the patient is put in the lithotomy position and the vagina douched and scrubbed with antiseptics. The cervix is drawn forward so as to put the posterior wall of the vagina on the stretch, and a transverse incision made down to the peritoneum. Sutures are then passed in such a way as to unite the peritoneum to the posterior wall of the vagina and, at the same time, compress any vessels lying in the cellular tissue. If the Douglas cul-de-sac has been obliterated by adhesions, a second row of sutures may be necessary.

The index finger is now inserted into the wound and the broad ligament passed forward. A curved needle with a heavy suture is entered in the lateral fornix about one inch from the angle of the wound, and carried deeply enough to pass above the lower branch of the uterine artery, and then brought out about one and a half inches from the point of insertion. The suture is then firmly tied, and the same thing done on the other side. The anterior fornix is now opened, and lateral incisions are made connecting this with the posterior incision. The bladder is carefully dissected from the uterus up to the peritoneum. The uterus is now turned backward and ligatures are passed through the broad ligament and tied. Usually the ligament is tied in three sections. After ligatures are tied in both broad ligaments, the ligaments are divided between the body of the uterus and the line of ligatures and the tumor removed. The parts are now sponged and freed from blood. The wound in the peritoneum may be closed, but it is not necessary. A gauze drain is inserted and the patient put to bed. The patient should be catheterized for a few days. The bowels, after being confined

for a few days, should be moved by a mild laxative aided by a warm enema. Vaginal irrigation must be forbidden for a week or ten days (Fig. 246).

The details of the operation vary with different operators, but the method above described in brief is satisfactory. Some operators use forceps to prevent
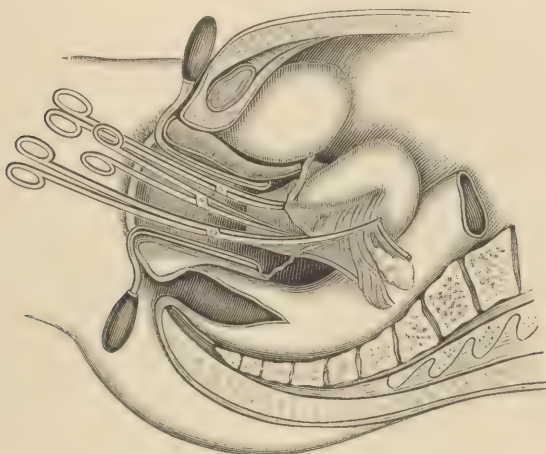
Vaginal hysterectomy: forceps on left broad ligament.

hemorrhage from the broad ligaments, leaving them *in situ* for forty-eight or seventy-two hours.

The *dangers* of the operation are those common to all severe operations—shock, primary or secondary hemorrhage, and sepsis, plus the danger of injury to the ureters at the point where they lie close to the uterus. There is also some danger of opening the bladder. These dangers can be avoided by operating carefully.

Abdominal Myomectomy.—The following operations are done through the abdominal wall: After the customary antiseptic precautions the abdomen is opened in the median line and the tumor exposed. The capsule is freely incised and the tumor shelled out. The resulting cavity may be closed by deep sutures or, if thought necessary, can be drained into the vagina. The tumors suitable for this method of operating are the non-pedunculated subserous ones and those which have developed into the broad ligament. Pedunculated tumors are removed after separating any adhesions, dividing them between ligatures if necessary, and then division of the pedicle after ligating it.

Abdominal hysterectomy may be *complete* or may stop at *supra-vaginal amputation of the cervix uteri*. Each method has its advocates. Results seem to be equally satisfactory in both methods. In the former less detail of technique is necessary.

After both operations atrophic changes follow in the vaginal walls, making it difficult sometimes to state which operation was performed. It will thus be seen that the alleged advantage of the incomplete over the complete operation—viz. that the stump of the remaining cervix serves as a keystone to the vaginal arch—is not a good argument. Increased chances of infection through the cervical canal

are imputed to the more complete operation by its opponents. It is found, however, that at times infection follows both operations. It is found also that both operations are performed at other times without any infection following. Hence, when infection follows at all, it may fairly be attributed to some fault in operative technique. Dr. Eastman of Indianapolis advocated the best compromise between the two operations yet offered. He neither stops with the supravaginal amputation nor does he incise the vaginal vault. He enucleates the body of the remaining cervical stump from its investing membrane, and does not incise the vaginal tract at all.

The abdomen being sufficiently opened to eventrate the tumor after severing adhesions requiring it, the first point to be settled is the method of securing the vascular supply to the tumor. The steps necessary to secure this end vary vastly. In some cases, where the broad ligaments are not split up by the growth projecting into them, the procedure is simplicity itself. In other cases, where masses project from the sides of the tumor into the broad ligaments, the difficulty of securing hæmostasis is rarely excelled in the whole range of surgery. The one point never to be lost sight of is the fact that the broad ligaments contain the vessels supplying the neoplasm. When the growth rides high and free in the abdomen and its pedicle is the cervix uteri, not increased in its dimensions, and the broad ligaments are comparatively flabby and relaxed, the simplest and speediest method of operating is to place a large snap-forceps at an angle of about forty-five degrees from the tumor, diagonally across the broad ligament down to the cervix, avoiding the ureter. The forceps will thus be made to pass from the upper part of the cervix upward and outward. It is better to place them thus than to place them parallel with, or transversely to, the axis of the tumor. To render the operation as nearly bloodless as possible it is necessary to adjust the forceps most carefully; which means that they must be made to include the uterine artery. If the uterine artery be secured in the forceps, the ovarian artery will also be caught. It is necessary in adjusting the forceps to make the points of the jaws go clear down to the cervix. This is best done by making the tips of the jaws at first grasp the cervix a little, and then by a slight retraction of the handles let the jaws pass over the rounded contour of the cervix as they are closed. The bladder as well as the ureter must be avoided by the forceps. With both forceps adjusted the broad ligaments are cut from the tumor, with a knife or a heavy scissors, down to the junction of the cervix and forceps. By following down the cut closely with a folded towel, the outflow of the residual blood from the tumor into the pelvis can be prevented, thus saving a certain amount of sponging. After both ligaments are severed the bladder is dissected from the cervix as speedily as possible. Then a flap of peritoneum is removed from the posterior surface of the tumor. The two dissections thus made, anteriorly and posteriorly, can have a crescentic or a straight border above as the operator desires. All that is necessary is to dissect off enough of the peritoneal membrane to supply an abundance of covering for the stump of the cervix. Then it will be found that naught but the cervix remains to be amputated. This being done, the uterus and the tumor are removed.

The next step consists of dealing with the stump. Due caution against contaminating the peritoneum with the cervical secretions must be observed. After forcible dilatation of the canal with a large snap-

forceps its entire surface should be rendered satisfactorily aseptic by some approved means. There seems to be none superior to the free use of the Paquelin cautery. After its use the canal should be traversed by a piece of aseptic gauze crowded well down into the vagina with a sound, leaving the upper end of it flush with the top of the amputated cervix. This serves perfectly as a means of promptly draining away all wound-secretion through the vagina. It can be removed at the end of two or three days.

Attention should now be paid to the hæmostasis. Along the border of the amputated broad ligament, just outside the jaws of the large snap-forceps, the arteries can be picked up and secured. Silk or catgut can be used on a needle. The arteries can thus be secured singly with the use of a minimum amount of ligature without going outside of the folds of the broad ligament. This is a method better than to gather up the entire end of the broad ligament into a large bunch, which necessitates a longer and larger-sized piece of ligature, as is commonly done. This method of tying the arteries singly, as is done in a leg amputation, is surgically more correct.

After securing the vessels in each broad ligament, all that remains to be done is to close the folds of peritoneum over the stump. To facilitate this step, an Eastman staff can be introduced through the vagina into the Douglas cul-de-sac, and the seat of the operation can be thrust upward almost into the abdominal incision. This is a great improvement over the attempt to cover the stump as it lies at the bottom of the pelvic cavity. The edges of the peritoneal flap are now brought over the cervical stump and turned in, and the surfaces are closed by a continuous Lembert suture of silk or catgut from one side to the other. At each angle of the wound the broad-ligament stump may be gathered in and covered completely out of sight. After completing the suturing there is naught but peritoneum to be seen, the field of the operation being completely extra-peritoneal. Nothing now remains but to close the abdominal incision.

The length of time required to perform hysterectomy as herein described varies with the operator's dexterity. Simple uncomplicated cases can be completed with ease in from fifteen to forty minutes. The amount of blood lost is the least attendant upon any of the suggested methods of performing abdominal hysterectomy.

The more complicated cases are those wherein one or both broad ligaments are split up by projections into them of portions of the tumor. Where the projections are small they are easily managed; where they are large the whole tumor is so solidly bound down by the unyielding laminæ of the ligaments that the difficulties encountered are enormous.

The first step is to grasp the apex of the tumor with a large volsellum forceps and entrust it to an assistant, who draws the growth to one side as far as it can be drawn without tearing it. The chief danger lies in catching up the ureter, which may be forced out of its normal course to an astonishing extent by a projecting mass of the tumor. A large double ligature is now thrust through the portion of the broad ligament outside of the intraligamentous mass. One portion is now tied close to the mass and divided, and the other portion is forced outward, tearing the ligament for an inch or more, and tied. The tied portion is now cut between the ligatures, when the mass can be raised somewhat out of its bed. Beneath the incision another double ligature can now be passed and tied similarly to the first one. Upon cutting through this second portion of the broad ligament the entire mass can be well raised out of its bed and the cervix on that side will be exposed. Sometimes liberation can be sufficiently accomplished after the use of one set of ligatures only. The opposite side can be treated in like manner.

Then the whole mass can be lifted up and the remaining steps of the operation performed as heretofore described.

In these cases the *bladder is sometimes greatly distorted*, and a correspondingly greater amount of care is required to avoid injuring it. When it is opened it must be closed perfectly, care being taken to cover the wound with peritoneum.

Another procedure now much in vogue is to make the *cuff operation*. After enucleating the tumor, its peritoneal covering is sewed into the lower angle of the abdominal incision, permitting drainage to be discharged externally. After filling the cavity of the peritoneal covering of the tumor with gauze and bringing it outside, the abdominal wound is closed. Free drainage is thus secured, and as the cavity closes the amount of gauze is progressively decreased with successive dressings till the cavity is obliterated.

Castration.—The idea of this operation is to bring about the menopause prematurely, for it has been observed that with the menopause myo-fibromata decrease in size and their symptoms become less, to *nil*. This operation is indicated when the hemorrhages are severe and the condition of the patient is such as to contraindicate the more hazardous operations. The operation is contraindicated in cases of large tumors, which are liable to suffer from circulatory disturbances secondary to the operation, and in cases where the pressure-symptoms are marked.

A median incision is made at the level at which the ovaries are thought to lie, varying in cases with the size of the tumor. The ovaries are sought out and drawn to the incision. The pedicle is tied with a single ligature or in parts according to its thickness. The ovary is now removed, care being taken to get it all. If necessary, separate ligatures are now applied to the vessels in the stump. The stump is now cauterized with the thermo-cautery and dropped back. The other ovary is treated in the same way. In many cases this operation checks the hemorrhages at once or in a varying period of time. It checks the growth of the tumor and often causes marked diminution in its size.

CANCER OF THE UTERUS.

Carcinoma of the uterus may commence in the body or in the cervix, but the latter is the usual point of origin. Some cancers begin in the cervical mucous membrane, either deeply in the form of nodules or merely in inflamed mucous membrane or from the surface. They are usually adeno-carcinomata or the ordinary medullary forms. Less frequently they produce papillary excrescences. The external os may escape for a considerable time, but sooner or later it and the entire vaginal portion are destroyed. The parametrium is involved early. A large number of carcinomata start from the vaginal surface of the vaginal portion. They are usually flat carcinomata, but when glands are present adeno-carcinoma may develop from them.

These cancers early involve the vagina and perivaginal tissues, also the cervix and parametrium. The cervical cancers often lead to the formation of large ulcers, causing great destruction. An exact anatomical diagnosis in these cases may be difficult, even when post-mortem, but usually examination of the lymph-nodules involved will remove every doubt. Carcinoma of the cervix also takes the form of cauliflower-like masses which may be so large as to completely fill the vagina.

Carcinomata of the body of the uterus are much less common. They cause thickening of the uterine walls, with consequent enlargement of the uterus, either as a diffuse infiltration or as circumscribed nodules. Sections usually show an adenomatous structure. The inner surface of the uterine wall is usually ulcerated, but they may be polypoid or papillary excrescences. The peritoneum is involved early, the cervix later. It is important to know what Sulig has recently demonstrated, that the extension of carcinoma along the lymph-channels is far beyond the microscopical limits of the tumor, and that in cases of carcinoma which seemed sharply

limited to the cervix bands of cancer-cells were found in the lymph-channels between the outer and middle muscular layers of the uterus almost to the orifice of the tubes.

No more can be said of the ETIOLOGY *of cancer* of the uterus than can be said of cancer elsewhere. It is a disease of adult life. It occurs more frequently among the poor than among the rich. It is much more frequent in women who have borne children than in those who have not. Lacerations of the cervix predispose to carcinoma. Carcinoma of the uterus, metastatic to carcinoma of some remote organ, is very rare, but we do find carcinoma of the uterus due to extension from the rectum or bladder, although the extension is usually in other directions. We also find the so-called carcinoma by implantation—*i. e.* carcinoma of one lip of the cervix transferred by direct contact to the other lip—or carcinoma of the cervix following carcinoma of the body of the uterus, with a band of normal tissue between. The existence of carcinoma by implantation is important, as it warns us to be careful in operating to avoid contact of a raw surface with the carcinomatous tissue.

SYMPTOMS.—Many patients suffer from *pain, hemorrhage,* and *vaginal discharge* even early in the course of the disease, while others remain free from any symptoms even with well-advanced carcinoma. The *pain* varies in character and intensity—pain in the back, colic-like pains, and peritoneal pains. The *hemorrhage* is at first merely an increase in the amount of the menstrual flow, or, if the patient be past the menopause, she usually thinks that the menstruations have returned. Later it becomes more frequent and abundant, and is readily excited by any trauma, cohabitation, defecation, or exertion. When necrosis of the superficial parts of the tumor occurs there is a most foul *odor* accompanying the *discharge*. Anæmia, emaciation, and cachexia rapidly develop. The patients suffer from sleeplessness and anorexia. When the bladder and rectum become involved, symptoms of their disturbed functions are added.

In well-advanced cases the DIAGNOSIS presents no difficulties, but in early cases, where the diagnosis is so very important, it can often be made only by the microscopical examination of a bit of tissue removed.

The PALLIATIVE TREATMENT is, unfortunately, the one which must be most often employed, because most cases are not seen until too late for radical removal of the disease. If the uterus is fixed and immovable or if the pelvic lymph-nodes can be palpated, effort at radical removal is useless. If the pain, hemorrhage, or discharge demand treatment, the *curette and cautery* are our best means. All of the neoplasm which can be reached should be removed and the raw surface cauterized with the thermo-cautery or some chemical caustic, such as chloride of zinc, bromine, chromic acid, or perchloride of iron. The vagina is then tamponed with iodoform gauze. The curetting often relieves the pain as well as the hemorrhage and discharge. If it does not, morphine must, sooner or later, be resorted to. Tonics and nourishing diet are necessary, and any symptom which arises must be treated as seems best.

The Only Operation for Radical Cure is Hysterectomy.—Amputation of the cervix, in view of the recent pathological investigations, should not be attempted, even in the most favorable cases ; for, although permanent cures do result from this operation, the dangers of recurrence

are too great. The best method of performing hysterectomy for carcinoma uteri is still a matter of dispute. Some operators prefer the *vaginal* and some the *abdominal* method, but probably the *combination of the two is the best*. Because of the danger of implantation of the carcinoma, all parts of the cancer which can be removed by the curette are removed, the base cauterized, and the mouth of the uterus closed by sutures or the cavity packed with gauze before any incision is made in the vagina. The vaginal wall is then divided by a circular incision far enough away from the cervix to be in healthy tissue. The dissection is then carried upward as far away from the uterus as possible, taking care not to injure the rectum or bladder. The next step in the operation is opening the abdomen. The broad ligaments are then ligated as far away from the uterus as possible, and then divided. The reason for ligating the broad ligaments through the abdomen rather than through the vagina is because any extension of the carcinoma into the parametrium can be given a wider berth when operating through the abdomen than when operating through the vagina. The *after-treatment* is the same as after laparotomy for other purposes.

THE OVARY.

Ovarian cysts are the most common neoplasms found in the ovaries, but before describing them brief mention should be made of cystic changes in the Graafian follicles. They occur especially in cases of chronic oöphoritis or perioöphoritis. The cysts commonly reach the size of a cherry or walnut, and are often multiple, while the larger ones —and they may be as large as the uterus at term—are usually single. The wall is thick, but with the smaller cysts it is often thin. There are no septa or remains of septa, no papillary excrescences, and the epithelial lining of the cysts is the cylindrical follicular epithelium, normal in shape or in the larger cysts flattened by pressure. The cyst-content is thin and serous and never stringy. It contains but few formed elements, but sometimes it is mixed with blood. A satisfactory explanation of the development of these cysts cannot as yet be given. (*Vide* Vol. I. Chap. XXVI.) Somewhat similar cysts occur in the corpus luteum.

The cystomata or adeno-cystomata of the ovaries are true neoplasms. They occur on one or both sides, vary in size up to or beyond one hundred and forty pounds or more, may be single or multiple, and show many variations in the thickness and lining of their walls and the character of their contents. There may be many small cysts, but there are one or several large cysts with numerous small cysts. Daughter cysts often develop in the wall of the original cyst. Usually the cyst is multilocular, but some are originally unilocular, while others become so by the fusion of the separate cysts. The wall may be thin and transparent, but more frequently it is thick and strong. Adhesions to neighboring organs are common, and may be very extensive. The epithelium lining the cysts is usually cylindrical, but in large cysts may be flattened by pressure of the contents into cubical or even flat cells. Ciliated epithelium also occurs, but, as a rule, only in the so-called papillary cystoma—*i. e.* those in which we find papillary, cauliflower-like growths on the inner surface of the wall. These papillæ vary in length, thickness, and the number of their branches. They may be few or so abundant as to entirely fill the cavity of the cyst or even rupture its walls. The outer surface of these cysts is usually free from papillæ, but they are often present, and not rarely we find metastases of the papillæ to the peritoneum.

The contents of the cysts vary in specific gravity from 1010 to 1030, are alkaline, and show little tendency to coagulate. The consistency varies from thin, slimy, almost serous to thick jelly-like fluids. In some cases the fluid shows nothing to distinguish it from the fluid of an ascites. The color varies from clear and watery through green, yellow, red, to brown, and sometimes bloody or purulent. There is a large amount of cellular débris, red and white blood-corpuscles, epithelial cells of various kinds, colloid concretions, crystals of blood-pigments, and rarely cystin. Sometimes the presence of squamous epithelium, hair, teeth, or bones will show that the cyst is a *dermoid*. Chemical examination of the fluid shows albumen, metalbumen, and sometimes urea. (*Vide* Vol. I. p. 25.)

The cysts usually develop toward the abdominal cavity (Fig. 247), making a *pedicle* of the ovarian ligament, the broad ligament, and often the tube also. This *pedicle* may be long and slender or short and thick.

Fig. 247.
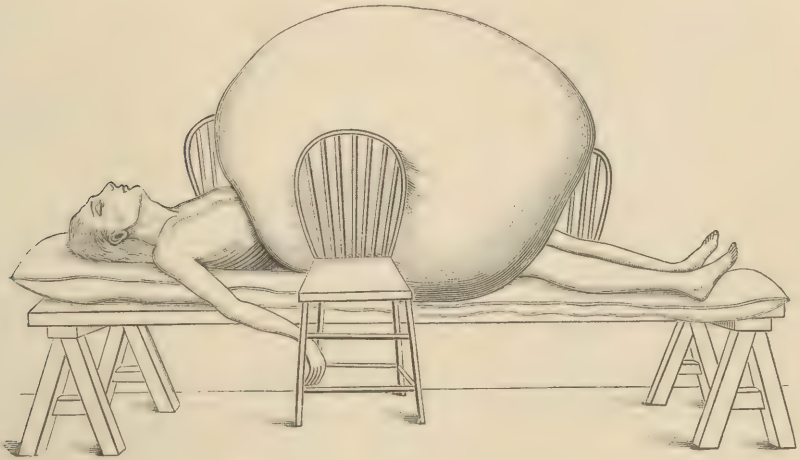
Enormous ovarian cystoma (Rodenstein).

Sometimes the cysts develop between the layers of the broad ligaments —intraligamentous cysts. There are numerous *secondary changes* to which these cysts are liable. *Torsion of the pedicle* is not rare, and happens the more easily the longer the pedicle and the freer the surface of the cyst is from adhesions. When torsion occurs the veins of the pedicle are compressed: hyperæmia, stasis, and necrosis result unless the blood-supply through the adhesions is sufficient to prevent it. If *necrosis* occur, *suppuration* or *gangrene* develops from infection with microorganisms. *Fatty degeneration* both of the epithelial lining and the cyst-wall is frequent. *Calcification*, either diffuse or localized, is common, especially in the papillary form. *Hemorrhage* into the cyst is also common. *Rupture of the cyst into the abdominal cavity* occurs, leading to symptoms of *acute peritonitis*. If the cyst-contents are thin, they are completely absorbed, but the thicker they are the less complete is the absorption. Rarely the cysts rupture into the bladder or intestines. Sometimes sarcoma, and more frequently carcinoma, develop from cyst-walls.

Entirely different from the form of cyst just described is the **dermoid cyst** which occurs with relative frequency in the ovaries. (*Vide*

Vol. I. p. 398.) Usually one, but sometimes both ovaries, are involved in the process. The dermoid tumors vary in size up to an adult head, rarely larger—are hard and generally globular. They contain masses of fat and hair, usually skin showing sebaceous follicles and sweat-glands, and often teeth, bones, and cartilage. They are not likely to grow rapidly or reach any considerable size, but the danger of infection and suppuration in the cyst and of torsion of its pedicle is sufficient to warrant removal whenever they are found.

Practically, nothing positively is known about the ETIOLOGY of this condition. The cysts rarely start before twenty or after fifty years of age, but they have been found in the new-born and as late as eighty years. They are more frequent in those who have not borne children than in those who have.

The onset of SYMPTOMS is gradual. At first there are only indefinite reflex disturbances, due to congestion and stretching of the appendages. Sometimes, even very early, severe radiating pains on the diseased side appear with tenderness on pressure. In other cases the first symptoms may be due to pressure on the pelvic viscera, vesical and rectal tenesmus, incontinence or retention of urine, constipation, hemorrhoids, and also pains in the legs and œdema from pressure on the pelvic nerves and vessels. All of these symptoms may disappear on the sudden escape of the tumor from the small pelvis into the abdominal cavity. The menstruations are often profuse and usually painless. There is often profuse leucorrhœa. Sterility is a frequent, but not inevitable result, so that pregnancy can occur even when both ovaries show cystic degeneration, and, if the cyst or cysts are small and not fixed in the pelvis by adhesions, the pregnancy can go to term without serious complications. When the tumor has reached a considerable size disturbances of the gastro-intestinal tract are common. Breast-changes similar to those of pregnancy may appear. The urinary secretion may be scanty from pressure of the tumor on the kidneys. The upward displacement of the diaphragm causes the ordinary symptoms of cardiac and pulmonary insufficiency. Adhesions between the tumor and the surrounding parts are often the cause of serious symptoms, such as intestinal colic, vomiting, etc. These symptoms may be altered by change in the position of the patient. Sooner or later malnutrition, anæmia, and cachexia appear. These patients often have a peculiar facial expression, the *facies ovariana*, but this must be seen to be recognized.

In many cases there are absolutely no subjective symptoms, and the patient's attention is first attracted by the increasing size of the abdomen.

When complications arise, such as torsion of the pedicle, rupture of the cyst, or hemorrhage into the cyst, the symptoms are sudden and severe. Shock, acute anæmia, and the like are followed often by symptoms of peritonitis.

Examination of the patient should be preceded by free catharsis, aided by copious enemata, until one is certain that the colon is free from fecal masses. The bladder should be emptied with the catheter if there is any reason for suspecting that the voluntary evacuation is incomplete. If the resistance of the abdominal walls be too great or the pain too severe, the examination should be made under anæsthesia. The patient should be placed on the back with abdomen fully exposed. The size of the abdomen varies with the size of the tumor, but the enlarge-

ment is usually asymmetrical, the side on which the tumor lies being the fuller. Percussion over the tumor gives dulness, but unless the tumor is closely adherent to the abdominal wall the area of absolute dulness is less than the size of the tumor as shown by palpation. If dulness is present in the flank, it is not altered with position of the patient, as it is in cases of ascites. Fluctuation of the cyst-contents is the plainer the more nearly the cyst is unilocular. Palpation of the tumor is done both through the abdominal wall and by bimanual manipulation. It should be done gently, for fear of rupturing the cyst or tearing some adhesions. No general rule can be given as to the position of the uterus, for it is dependent on a variety of factors—the size of the cyst, its point of origin, the presence or absence of adhesions. The uterus may be pulled up out of the pelvis or pushed down to the vulva. It may be forward or back or to one side. The length of the cavity is not usually increased, but it may be.

The *differential* DIAGNOSIS *of ovarian cysts* is a very broad matter, so that there is no abdominal organ which does not under some circumstances enter into consideration. Mundé gives the following list of possibilities : *Obesity, œdema, tonic spasm of the abdominal wall, tympanitis, fecal tumor, dilatation of the stomach, distended bladder, hæmatometra, physometra, hydatiform mole, hydrosalpinx, ascites, encysted dropsy, hæmatocele, cyst of the broad ligament, renal cyst, splenic cyst, hepatic cyst, parasitic cyst, omental and pancreatic cyst, uterine cysto-fibroma, uterine fibroma, enlarged spleen, enlarged liver, sarcoma of the abdominal nodes, malignant disease, omental tumor, displaced kidney, displaced liver, pregnancy both normal and extra-uterine, pregnancy with amniotic dropsy, with ovarian cyst, and with a dead child.*

Even this formidable list might be extended. Fortunately, the means of differentiation in most of the cases readily suggest themselves. When the cyst is small the differentiation from other small tumors near the uterus may be difficult. A small focus of inflammation in the periuterine cellular tissue can usually be distinguished by the history or presence of signs of inflammation. These tumors are less sharply circumscribed than the cysts. Extra-uterine pregnancy must be thought of when there is amenorrhœa, vulvar discoloration, and breast-changes. Retroflexion of a gravid uterus is suspected when the tumor is found in the cul-de-sac with the usually early signs of pregnancy. When the tumor rises out of the pelvis other questions arise. Differentiation from pregnancy, especially when an amenorrhœa exists, has caused confusion. The presence of any of the certain signs of pregnancy settles the question, but in some cases time or an exploratory laparotomy may be necessary. When both pregnancy and a cyst exist the question is still more difficult. Ascites may resemble a large cyst, but with ascites the flanks are more distended, there is usually an area of tympany about the umbilicus when the patient is flat on her back, and the fluid moves freely with the changing position of the patient. Examination of other parts of the body will usually show the presence of some cause for the ascites. It must also be remembered that papillary cystoma not infrequently causes ascites. *Localized tubercular or cancerous peritonitis* is often difficult to recognize. The presence of tuberculosis in other parts of the body must suggest the possibility of a tubercular peritonitis. With carcinoma we may be able to palpate irregular nodules. Puncture of the abdomen may greatly facilitate palpation, but this procedure should always be done with great care, and it is not certain that a small exploratory incision is not a preferable plan. Microscopical and chemical examination of fluid removed may be of great assistance. Renal tumors, hydronephrosis, sometimes cause confusion. Here the history, the examination of the urine, the relation of the tumor to the colon after inflation of the colon with air, and the presence of a large amount of urea in the fluid of a hydronephrosis will usually render the correct diagnosis possible. When in any case careful and repeated examinations have failed to yield certain results, an exploratory incision should be made.

The only TREATMENT of ovarian cysts is removal. The patient is prepared as for other cœliotomies. The abdomen is opened in the median

line just above the pubes. Any adhesions are separated, the smaller torn with the fingers, the larger divided between ligatures. In some cases the adhesions are so abundant that the operation must be abandoned. After freeing the cyst from adhesions the contents are drawn off through a trocar, taking care that none of the fluid escapes into the abdominal cavity. The sac is now drawn out through the abdominal incision. The pedicle is tied with a heavy ligature, usually in two or more parts. The cyst is cut away, and after tying with separate ligatures any large vessels found in the stump, the stump is dropped back into the abdomen and the incision closed. The *after-treatment* is the same as in other laparotomies.

The Parametrium.

Acute inflammatory processes in the para-uterine cellular tissue are most commonly the results of infection during labor or abortion. They may also follow operation on the genitalia or be due to extension from an infective inflammatory process existing in some of the pelvic organs—the tubes, ovaries, uterus, or rectum.

There is serous and cellular infiltration of the cellular tissue, varying in extent and location, but more often found in the broad ligaments, where it may remain or extend to all the uterine ligaments, the abdominal wall, the post-peritoneal and post-rectal cellular tissues. It may take the form of a diffuse phlegmon, as thrombo-phlebitis or thrombo-lymphangitis. The exudate may undergo complete resorption and the parts be restored to their normal condition, or the exudate may become purulent, forming an **abscess**. The abscess may be single or there may be many communicating with each other by tortuous passages. If untreated, the pus may undergo partial absorption, caseation, and calcification, but, as a rule, such abscesses increase in size and extend along lines determined by the fascial planes and the influence of gravity. They often rupture through the abdominal wall, the vagina, the rectum, or the bladder. They may also rupture into the peritoneal cavity. Another possible outcome of a cellular infiltration is its organization with the formation of new fibrous tissue. A similar formation of new tissue occurs about abscess-cavities unless the abscesses are promptly and thoroughly drained.

Cases of parametritis are almost invariably associated with more or less extensive **perimetritis**.

The SYMPTOMS are the general symptoms of all acute septic processes combined with the symptoms of the local trouble. Usually a chill, often very severe, is the first sign; the pulse and respiration are rapid. The temperature is high and interrupted at varying intervals by chills. Pain from tension of the ligaments and abdominal walls and from pressure on the pelvic nerve-trunks, added to that of the usually accompanying pelvic peritonitis, is severe. Vesical tenesmus is often troublesome. Vomiting and tympany of the intestines are common. The general strength is rapidly undermined. The emaciation becomes extreme. The symptoms of rupture of an abscess into the general peritoneal cavity are those of a severe generalized peritonitis. In the more favorable cases the symptoms are less severe and of shorter dura-

tion. Vaginal examination shows local heat, swelling, and tenderness, with a generally boggy feeling. Later the swelling increases, causing displacement of the uterus. If pus form, fluctuation can usually be discovered.

TREATMENT.—In the very early stages the patient should be kept in bed under the influence of opiates, with the local application of the ice-bag. The general health of the patient should be maintained by the use of alcoholics, quinine, and strychnia. If suppuration seems to be inevitable, cold should give place to hot applications and douches. As soon as a focus of pus can be discovered it should be opened and drained. It is usually best to locate the pus with an exploring syringe, and open along the needle with the thermo-cautery or sharp-pointed scissors, taking care to avoid any pulsating vessels and withdrawing the scissors open. The abscess-cavity should be explored to see whether it communicates with any other cavities. If it does, the opening between them should be enlarged sufficiently to secure free drainage. The abscess-cavity should be irrigated frequently with antiseptic solutions, and free drainage be maintained until the cavity closes throughout. If there is much new tissue formed after the abscess is closed, pelvic massage, combined with hot douches, iodine locally, should be used to limit the deformity resulting from the contractions of the new tissue, and as far as possible to cause the absorption of such tissue.

THE PERIMETRIUM.

Perimetritis, or pelvic peritonitis, is most often secondary to disease of the pelvic organs, though it occurs also as a part of a general peritonitis. The most common cause is infection following labor or abortion. Other causes are acute and chronic endometritis and metritis, gonorrhœa, inflammation of the tubes and ovaries, malposition and tumors of the ovaries, and exposure, especially during menstruation.

The inflammation may lead to the formation of abundant fibrinous or purulent exudate, filling up the cul-de-sac of Douglas, and matting together the pelvic organs and such of the intestines as happen to lie in the pelvis. After a varying period of time the exudate may be absorbed; more frequently abscesses form which sooner or later perforate in some direction. These cases most frequently follow puerperal infection. Much more important, because much more frequent, are those cases in which the exudate is less abundant and fibrinous, and by its organization leads to the formation of adhesions between any two peritoneal surfaces which happen to be in contact. These adhesions by the contractions which they undergo lead to the most diverse displacements and distortions of the pelvic organs, to circulatory disturbances by compression of arteries and veins, and to disturbance of the functions of the organs. The uterus is dislocated, atrophied when the blood-supply is cut off, or passively congested when the veins are compressed. The nutrition and function of the tubes and ovaries are altered. They are dislocated and become chronically congested and inflamed. The function of the bladder and the rectum suffers.

The SYMPTOMS vary as greatly as do the symptoms of generalized peritonitis. Even most severe purulent pelvic peritonitis may exist some time without causing marked symptoms. The acute form usually begins with a more or less marked chill, followed by high temperature and frequent pulse, constipation, followed shortly by tympanitic distention of the intestines, vomiting, and collapse. There are localized pains

and tenderness with vesical irritation. In less acute cases the general symptoms are less marked, and the local symptoms, especially the pain, come to the foreground. The pain is severe, and is increased by motion, menstruation, and examination. The patients lose strength rapidly, suffer from insomnia, and often very much from vesical tenesmus. The chronic cases often develop without causing any subjective symptoms whatever, and the earlier existence of a pelvic inflammation is shown only by the resulting adhesions. The symptoms in these cases come on later from the disturbance of the uterus, bladder, and rectum—profuse menstruation, leucorrhœa, vesical tenesmus, constipation, pain in the back, sterility, or repeated abortions.

Examination of the acute cases shows extreme tenderness over the abdomen, tympany, and tension of the abdominal walls. Vaginal examination shows the uterus fixed by the exudate about it, especially in the Douglas cul-de-sac. The vaginal fornices are bulging. Pulsating vessels are often felt. Examination of the cases which develop insidiously show some abdominal tenderness and considerable vaginal tenderness. The uterus is usually displaced backward and fixed. Bands of tissue irregularly arranged can often be felt. The severe cases coming on after labor or abortion may cause death rapidly or the exudate may soften and be discharged. Other possibilities are slow absorption or organization of the exudate. Complete recovery does occur, but it is exceptional. Even though the symptoms disappear for a time, they usually reappear upon the slightest provocation.

The TREATMENT of the acute cases consists in ice locally and rest in bed. The pain must be controlled by opium. The bowels must be kept open by laxatives. The strength should be maintained by alcoholics and tonics. After the more acute symptoms have disappeared hot local applications are used. If pus form, the abscess must be drained freely, as already described. The chronic cases should pass several hours in bed and the bowels be kept open. All repeated or prolonged examinations, the use of the uterine sound or pessary, are contraindicated, because of the danger of setting up an acute exacerbation of the chronic peritonitis. Hot or cold applications should be used for the pain. In some cases the extirpation of the tubes, ovaries, and the adhesions about them is warranted.

THE FALLOPIAN TUBES.

Inflammation of the Fallopian tubes may be acute or chronic. Although *salpingitis* was not recognized until a few years ago, the condition is far from being uncommon. The disease is rarely limited to the tubes. The uterus is diseased in about two-thirds of the cases, showing either acute or chronic endometritis, flexion, or version. Many cases show distinct traces of perimetritis, which, however, may be secondary rather than primary to the salpingitis. It is probable that the tubes are rarely the seat of primary inflammation, except for the not infrequent cases of tubal tuberculosis. Many cases are due to puerperal infection. Many cases are due also to acute gonorrhœa. Both tubes are diseased in about half of the cases, and when only one tube is involved the left is involved more frequently than the right.

The *pathological process* in the acute cases resembles acute catarrh of other mucous membranes. The membrane is swollen and red, with large or small ecchymoses under the epithelium, and, when the process is more intense, there is

a round-celled infiltration, causing thickening of the mucous membrane. There is increased secretion, slimy and usually clear, but sometimes mixed with blood. The epithelium is retained. When the inflammation is more severe and due to the pus-cocci or the gonococci, the changes are more marked. The epithelium is exfoliated; the deeper portions of the mucous membrane and muscularis are dotted with ecchymotic areas and thickened by an extensive round-celled infiltration. The muscle-fibres undergo fatty changes. Whenever two spots of the mucous membrane which has lost its epithelial covering come in contact, adhesions are liable to form, in this way dividing the cavity of the tube into irregular spaces, and in places, especially at the ends of the tubes, causing stenosis or atresia. The walls become thick and fibrous from organization of the exudate. The cavities are often distended with pus, which after a time may become caseous from absorption of its fluid and fatty degeneration of its formed elements. The peritoneum is usually involved early, the cause of the inflammation reaching the peritoneum either by extension through the walls of the tubes or by being carried by the secretions escaping through the abdominal end of the tube into the peritoneum. The peritoneum presents the changes common to inflammations of the serous membranes. The adhesions which form are often extensive. Their location is dependent upon chance.

The SYMPTOMS *of salpingitis* are not well marked, because they are almost invariably added to a preceding or coincident inflammation of some other part of the genital tract. A dull pain of varying intensity on one or both sides, and increased by exertion, menstruation, or copulation, is usually the first sign. To this may be added at irregular intervals signs of acute localized peritonitis. The menstruations are irregular, profuse, and painful. Occasionally the tube will empty itself into the uterus and a large amount of fluid escape into the vagina. At such times the pain is much relieved and the local findings are altered.

The presence of pus in the tubes—*i. e.* pyosalpinx—causes the general symptoms common to all suppurating foci. When suddenly developed there is the chill and the irregular temperature curve, rapid pulse, and rapid loss of strength and flesh. Pus-tubes rarely rupture into the free peritoneal cavity. The usually firm adhesions prevent this.

A positive DIAGNOSIS of salpingitis can be made only when the dilated tube can be differentiated by palpation from the exudate, and its connection to the uterus by the uterine end of the tube definitely determined. Palpation, in these cases, must be most careful, because of the danger of rupturing the tube, causing severe local or general peritonitis, or tearing an adhesion and setting up a hemorrhage which may be so severe as to necessitate a laparotomy to find and control the bleeding point.

TREATMENT for the acute cases is the same as for peri- and parametritis. Later, hot douches, iodine preparations locally, rest, proper diet, and regulation of the bowels often accomplish a great deal toward the absorption of the exudate. If, after this plan have been faithfully tried, the symptoms persist, the tube or tubes should be removed.

ECTOPIC PREGNANCY.

Extra-uterine pregnancy is the development of an ovum outside of the normal uterine cavity. Formerly this was thought to be a rare occurrence, but increasing experience shows that it is far from being so. Anatomically, the cases are classified according to the site of the development of the fœtus into *tubal, tubo-uterine* or *interstitial, tubo-abdom-*

inal, abdominal, subperitoneal, and others.   This classification is of but
little clinical value.

It is known that impregnation of the ovum often occurs near the
ovary.   Any cause which will prevent the passage of the impregnated
ovum to the uterus may cause an extra-uterine pregnancy.   The more
common of these causes are inflammation of the Fallopian tubes, pelvic
peritonitis about the tubes leading to constriction, tumor, or polypi in
the tube.

Tubal pregnancy is the most common form, and may occur at any
part of the tube, but most often in the middle third.   The tubal mucous
membrane undergoes changes similar to those of the uterine membrane
in the formation of the decidua.   During the earlier months of preg-
nancy the tumor resembles a hæmatosalpinx, and can be distinguished
only by finding fœtal parts or remains of chorionic villi.   Rupture of
the tube occurs early in the majority of cases.   It ruptures most fre-
quently into the peritoneal cavity, causing an intraperitoneal hæmatocele
which may be so large as to exsanguinate the patient.   Rupture between
the folds of the broad ligaments is more favorable, as the ligaments tend
to limit the hemorrhage.   Sometimes the fœtus dies early and the tumor
stops enlarging.   In these cases, after a few months, it may be difficult
to recognize the true nature of the tumor, the fœtus having entirely dis-
appeared.   In other cases the fœtus may live to term, developing in the
fold of the broad ligament, making the so-called subperitoneal extra-
uterine pregnancy, or free in the abdominal cavity as a secondary
abdominal pregnancy.

In the **tubo-uterine** or **interstitial form** the fœtus develops in that
part of the tube which lies in the uterine wall.   The pregnancy usually
continues longer than in the tubal form.   It may rupture into the uterine
cavity, with escape of fœtus and placenta through the natural passage,
or it may rupture into the peritoneal cavity.   Sometimes the pregnancy
goes to term.

In the **tubo-abdominal cases** the ovum develops in the abdominal
end of the tube.   The sac is made up in part by the tube and in part by
false membrane.   The sac is adherent to those organs with which it
comes in contact.   The placenta is usually located in the pelvis.   It may
go on to term, but as a rule ruptures.

Abdominal pregnancy may be primary—*i. e.* the ovum is impreg-
nated and remains in the abdominal cavity—but it is usually secondary
to rupture of some other of the forms.   The sac is usually made up of
thick false membranes, but it may be thin and transparent.   The pla-
centa is large and irregular both in site and shape.   When the ovum is
not strangulated, it usually develops to term, uninterrupted by hemor-
rhage or rupture.

The **uterus** is, as a rule, enlarged, and its mucous membrane shows
changes similar to those which occur with intra-uterine pregnancy.   Its
location varies with the site of the ovum, but it is more often displaced
forward or to the side opposite the ovum.

The patient presents all or many of the early signs of pregnancy,
but usually there is some irregularity in the course to attract attention.
The development of the breasts may not occur, or the menstruation,
after disappearing, reappears, often as a continuous flow.   There may be

expulsion of decidual membranes without any change in the signs of pregnancy.

When rupture occurs the SYMPTOMS are those of internal hemorrhage, varying in intensity with the amount of blood lost. *If pregnancy goes on to term*, we find symptoms due to compression of the rectum and bladder, intestinal colic, and recurring peritonitis. If infection of a hæmatocele or retained ovum occur, we have the symptoms of septicæmia and peritonitis, either generalized or local. If the suppuration is localized, it ends as other pelvic abscesses end. It also happens that after the death of the fœtus no symptoms result, the fœtus being retained as a non-infected foreign body. It may undergo calcification, forming a lithopædion. In such cases the condition may persist for many years without causing any trouble, but it is a constant source of danger, as it may at any time cause serious complications, such as intestinal obstructions.

The DIAGNOSIS *of extra-uterine pregnancy* previous to the fifth month cannot absolutely be made certain, because of the lack of positive signs of pregnancy previous to that time, but it must be suspected when several of the early signs of pregnancy are present, combined with irregular uterine hemorrhages, a disproportion between the period of the suspected pregnancy and the size of the uterus, and the presence in the pelvis of a tumor in close relation to the uterus. Commencing with the fifth month, we find positive signs of pregnancy combined with uterine hemorrhage, an irregularly-shaped tumor situated laterally, and a uterus not materially enlarged. Diagnosis of the variety of extra-uterine pregnancy is impossible. False labor is shown by expulsive pains, usually at term. Death of the fœtus is shown by the loss of the fœtal heart-tone with decrease in the size of the tumor, with softening.

It must be remembered in treating these cases that the danger of hemorrhage and sepsis is so great, and the chances of the spontaneous expulsion of the fœtus or the safe retention of a dead fœtus are so small, that to-day the only rational treatment of extra-uterine pregnancy is operation. The earlier treatments, such as starvation, bleeding, puncture of the cyst, strychnia to toxic symptoms, are abandoned. The use of morphine injections into the tumor previous to the fifth month is still sometimes practised with success, but it is more dangerous than laparotomy. The same thing can be said of the use of electricity. If before the fifth month extra-uterine pregnancy be suspected with any degree of probability, exploratory laparotomy should be performed, and, if the diagnosis be confirmed, the cyst and its contents should be removed. *Whenever rupture of the sac occurs a cœliotomy should be made at once*, without waiting for signs of serious hemorrhage. After the fifth month, if the fœtus be living, operation should be deferred until term or until signs of false labor appear, unless some indication for immediate operation develops. After the fifth month with a *dead fœtus* the operation should be made as soon as possible, even though the fœtus has been retained for years without causing any trouble.

Operations for extra-uterine pregnancy are of two classes—laparotomy and elytrotomy—*i. e.* operation *per vaginam.* The special features of each case must decide which of these operations shall be performed. Hemorrhage, which is the greatest danger of the operation, is best con-

trolled by the iodoform-gauze tampon. Whenever possible the entire sac and its contents should be removed. When the sac cannot be removed because of adhesions or for some other reason, it should be stitched to the abdominal incision, then opened and its contents removed, and then packed with iodoform gauze and allowed to close from the bottom.

When operation through the vagina is done, the vault of the vagina is incised at a point near the tumor, and the opening enlarged sufficiently to allow the extraction of the fœtus. The cord is tied and the placenta removed when possible. When impossible, the cavity is irrigated and packed with iodoform gauze.

CHAPTER XIV.

SURGICAL DISEASES AND INJURIES OF THE BREAST.

By Charles B. Parker, M. D.

The Development of the Breast.

The mammary glands appear in the human embryo in the second month as a considerable thickening of the epidermis in the position of the breasts; in the third month the proliferated epidermal cells of the rete mucosa form a slight depression in the true skin which is called the glandular area. Out of the wall of this area the gland-ducts and acini are formed by a further invagination of the skin by the epidermal cells; by the seventh month this process is well under way, and at birth the normal number of secreting lobules has been formed. At birth the nipple appears on a level with the skin. Gradually, in the first years the nipple rises as a prominence by the thickening of the epithelium about the gland-ducts and the development of a considerable quantity of involuntary muscular fibre, together with blood-vessels, nerves, and lymphatics. The manner of development of the milk-glands is after that of the sweat rather than of the sebaceous glands. According to Heidenhain, the secretion of milk also takes place after the manner of the formation of sweat, directly from the wall of the secreting structure, and not by a metamorphosis of the central cells as in the formation of sebum. The mammary glands are *developed in exactly the same manner in the male and the female*, and they remain identical until nearly the period of puberty. From this time onward the development is very rapid in the female, while in the male it does not extend beyond the nipple and areola. The male breast thus, from its origin and development, is equally liable to, though much less frequently the seat of, disease and tumor-formation.

Anatomy of the Breast.—The following data in the topographical anatomy of the female breast have an important bearing upon the surgical treatment of its injuries and diseases. Morris and others describe the mammary gland as extending from the third to the seventh rib from above downward, and from the sternum (which it slightly overlaps) to the axillary border from within outward. Astley Cooper gives its vertical extent from the third to the sixth rib, and Treves places it as covering the space from the third to the fifth rib. These observations serve to show that there may be considerable variation in the vertical extent of the gland. The breast is also not circular in outline, but presents three cusps—one overlapping the sternum, and the others toward the axilla, the one above, the other below. Heidenhain describes lesser extensions of the gland passing to the deep fascia, and even penetrating it in some cases. These portions of the gland have often been *left behind after operation* for malignant growth, and have become the source of a recurrence.

Each gland is composed of a connective-tissue framework enclosing secreting elements, blood-vessels, nerves, and lymphatics. The connective tissue from its firm attachment to the sternum and intercostal spaces spreads out into an outer and inner layer, between which the gland is supported: the outer layer does not form a true capsule, as it is reflected in with the ducts, and forms, together with similar subdivisions of the inner connective-tissue layer, the fibrous septa between the lobules of the gland, while more superficial subdivisions spread out and become incorporated with the under surface of the skin, forming the *ligamenta suspensoria* of Astley Cooper. The inner layer passes behind the costal margin of the gland sending fascicular fibres inward between the lobules, and others outward to unite with the fascia of the pectoral muscle. The glandular tissue is composed of from twenty to thirty lobules, each including numerous acini and ducts opening within a cen-

tral elevation, the *nipple.* The nipple is placed slightly internal to the middle of the breast over the fourth intercostal space. The direction of the nipple is outward and forward. The nipple is supplied with a rich anastomosing plexus of blood-vessels and erectile tissue.

The *areola,* the pigmented skin about the nipple, is very thin—contains a number of stubborn hairs and prominent *sebaceous glands.* During the later period of pregnancy larger glands appear in the areola, from which, according to Montgomery, milk can be pressed. Duval showed that they have no connection with the true milk-secreting portions of the breast. Luschka described them under the name of *glandulæ lactiferæ aberrantes.* The blood-vessels are derived from three sources : first, numerous important arteries given off from perforating branches of the internal mammary in the third, fourth, and fifth intercostal spaces, and distributed to the body, sternal, and costal sides of the gland ; second, large branches from the external mammary, and long thoracic arteries passing to the body and axillary sides ; and third, numerous though smaller branches from the thoracico-acromial artery to the superior border of the gland.

The *lymphatics* are very numerous, and form both superficial and deep plexuses within the gland. The lymph-stream flows from the gland in three directions—*outward,* to the axilla ; *inward,* toward the sternum ; and directly *backward,* to the muscular fascia. The principal stream gathered from the body and outer border of the gland passes in the lymphatic vessels along the lower border of the pectoralis major, pierces the fascia forming the floor of the axilla, and, after entering numerous lymphatic nodes, forms a trunk on the inner side of the axillary vessels. Opposite the first rib it penetrates the costo-clavicular ligament and terminates at the junction of the internal jugular and subclavian veins, on the right side uniting with the right lymphatic from the upper extremity, and on the left with the thoracic duct. Another set of vessels, gathering the lymph from the nipple and superficial portions of the gland, pass behind the axillary vessels and enter the absorbent trunk of the arm ; from the sternal side the lymphatics follow the veins of the perforating branches of the internal mammary artery, and enter the lymphatic nodes of the anterior mediastinum ; numerous lymphatics from the costal surface of the breast pierce the muscular fascia and intercostal spaces to join the lymphatics which accompany the aortic intercostal arteries. Volkmann, from his clinical observation, insisted that the communication between the lymphatic systems of the fascia and breast was not free—that the lymphatics of the muscular fascia formed, in fact, a temporary barrier to the lymph-stream from the breast, and thus to infection of the system in this direction. Ludwick demonstrated that the physiological lymph-current is from muscle to fascia. Heidenhain also proved the correctness of Volkmann's clinical observation, and further found that when the lymphatic vessels are once charged with infective elements these pass at once through the lymphatics of the intervening fat. The fat, therefore, separating the gland from the chest-wall, is no protection whatever against the transmission of infective elements. From the source and direction of the various lymph-streams it will be seen that cancerous tumors located in the outer portions of the breast and about the nipple would first produce secondary deposits in the axillary and clavicular lymphatics ; when located on the sternal and posterior portions of the mammary glands the first metastatic deposits might occur in the mediastinal and intrathoracic lymphatics rather than in those of the axilla.

ANOMALIES OF THE BREAST.

Complete absence of one breast (Amazon thorax, Hyrtl) or of both breasts is most rare. In those cases in which the breast has been absent the condition was observed to be associated with marked developmental defects in other organs, such as the uterus, ovaries, pectoral muscles, and ribs. **Supernumerary breasts** (polymastia) or **multiple nipples** (polythelia) are not so uncommon.

The mother of the Roman emperor, Alexander Severus, bore the name of Julia Mammea, from the fact that she possessed a third breast. The discovery by King Henry of a supernumerary breast on the person of the beautiful Anne Boleyn is said to have been the cause of her downfall and death.

The supernumerary breasts are usually located internally to, and below, the principal gland. The axillary border, and even Scarpa's space, have been the seat of functionating mammary glands. There seems to be no relation between these anomalies and diseases of the breast. Billroth says that in all his experience he has seen but one case—a carcinoma—occurring in a breast with two nipples. This observation is not altogether confirmed by other authorities, but we may safely say it is never necessary to remove these supernumerary organs simply because they are present.

Skin Diseases occurring on the Breast.

The skin and areola of the breast are liable to the various skin affections, especially eczema, which frequently occurs upon the nipple and areola. Eczema in this position, as well as other skin affections when they occur, do not differ in any essential character or in treatment from the same disease occurring on other parts of the skin. A peculiar affection of the nipple and areola very closely resembling eczema, and known as **Paget's disease of the nipple**, is occasionally met with. This disease receives its greatest importance from the fact that it is frequently followed by carcinoma in the breast. (For a detailed account of this subject see Chapter XXVI. Vol. I. (Carcinoma).

Wounds and Burns; Hemorrhage; Vicarious Menstruation.

The toughness of the skin on the breasts, and their mobility, are such that it requires a tremendous force to injure them, and in such cases the injury to the chest and its contents is far more important. Punctured wounds are occasionally met with; more frequently, however, the breast is wounded by *kicks* and *blows*. Such injuries and their treatment require no extended notice. They are chiefly noteworthy as forming the possible origin of subsequent tumor-formation within the breast.

Hemorrhages have been occasionally observed occurring in the breasts of young women and girls suffering from dysmenorrhœa, amenorrhœa, and other uterine disorders where there has been no external injury. Such an extravasation of blood is called *vicarious menstruation.* The extruded blood produces no pain and, at most, only a sense of fulness in the breasts.

The TREATMENT consists in supporting the breasts with a handkerchief bandage tied over the opposite shoulder and the application of dilute lead lotion.

Diseases of the Nipple and Areola.

Inflammation is especially liable to occur during the early days of the first lactation, and in subjects in whom the nipple is ill developed. The nipple receives a slight injury while the child is at the breast. The moisture incident to the act of nursing macerates and loosens the injured epidermis, which, separating, leaves a superficial excoriation. This deepens into a fissure and may extend to a considerable ulcer. The pain increases with every attempt made to place the child at the breast. The

dread of this pain leads the mother to extend the intervals of nursing, and the breast becomes distended with milk ; but the real danger in these fissures and ulcers lies in the fact that through them an avenue is opened for the introduction of bacteria, especially the streptococci and staphylococci. The result is inflammation of the substance of the gland. The prevention and treatment of this condition become of the first importance.

During pregnancy the nipples may be hardened by frequent bathing in alcohol and water ; and should they be imperfectly developed systematic efforts are to be made to draw them out. When the child begins to nurse the greatest care must be exercised to keep the nipples clean and dry. Immediately upon the child being taken from the breast the nipple and areola are to be washed in sterilized water and thoroughly dried ; upon the appearance of the slightest abrasion they must be kept perfectly clean by frequent bathing in boiled water and subsequent careful drying of the surface. A nipple-shield must be used when the child is again put to the breast.

Should a *fissure of the nipple* form as a result of this abrasion, it should be treated upon antiseptic principles. The greatest care is to be exercised in cleansing the nipple and fissure with boiled water after nursing, and the application of moist antiseptic dressings. Boracic-acid solution, gr. x to ʒj, or creolin, or even bichloride, 1 : 6000 or 10,000, may be applied to the breast during the intervals of nursing. Some impervious covering, such as oil silk or paraffin paper, should be applied over the moist dressing. All ointments should be avoided : not only are they of doubtful utility, but they chiefly serve as an impervious coating over the fissure, keeping in the secretions and bacteria and favoring their absorption. When the child is about to be put to the breast again, the dressings are removed and the surface thoroughly washed with sterilized water and dried. If the fissure persists and shows no tendency to heal, touching it with a sharp stick of silver nitrate will often start the healing process. Should these means fail after a reasonable trial, and the patient's health begin to suffer from the pain, and possibly both breasts become similarly affected, with the danger of infection from pyogenic microbes thus doubled, it is the evident duty of the physician to arrest the secretion of milk at once and in both breasts, whether they are both diseased or not. It is not sufficient to arrest secretion in the affected breast alone : the sympathetic relationship between the two is so intimate that nursing on a healthy mamma stimulates the diseased breast to renewed secretion. Such half measures have often protracted this painful affection for many weeks. The local application of belladonna ointment and the administration of potassium iodide in full doses have the approval of accepted practice ; but the equable continuous pressure secured by strapping both breasts is far more effective and affords more prompt and permanent relief.

Strapping the Breasts.—The patient is seated in a chair, the clothing removed from the bust, and the skin rendered aseptic by the use of soap and water, bichloride solution, 1 : 1000, alcohol, and finally ether. By taking this precaution the straps may be worn for a much longer time without producing irritation of the skin. From four to six strips of adhesive plaster, two inches wide and of sufficient length to extend from the opposite shoulder under the breast and back to the shoulder, are to be cut, and just as many more strips half this length. The

patient elevates the breast with the hand of the same side, while the surgeon carries the end of the plaster from the middle of the spine over the opposite shoulder obliquely downward under the breast and over the back to the point of starting. A second long strip is applied in the same manner, overlapping the previous one about one-third. A short circular strip is next applied, passing from the sternum over the breast back to the spine. The subsequent straps are then applied alternately until the surface of the breast is entirely covered, and firm compression is thus made upon it. The nipple and areola must be protected by a small, dry antiseptic dressing. The opposite breast is treated in the same manner. A circular cloth bandage is not necessary.

Acute Mastitis.

Acute inflammation of the breast may occur—first, at *birth ;* second, at *puberty ;* third, during *pregnancy and lactation. At Birth.*—Not infrequently the breasts of the new-born infant of both sexes secrete a milk-like fluid (" witch's milk ") for several days. The breasts are turgid, red, and tender. The practice of the untrained nurse of " rubbing away " the milk only aggravates the condition and leads to suppuration and abscess-formation. With intelligent, trained care suppuration will be rare, and for the inflammation that may occur it will be necessary, at most, to apply a compress wet with dilute lead lotion, and the process entirely subsides in from a week to ten days. At *puberty* a similar turgescence and inflammation of the breasts may occur. It is less liable to proceed to suppuration, and requires no treatment beyond careful protection of the parts.

During *pregnancy and lactation* acute inflammation is particularly liable to occur. Of 56 cases observed by Billroth, 50 occurred during this period—6 in non-pregnant women. Statistics seem further to prove that puerperal mastitis is more frequent upon the right than the left side, and rarely bilateral ; also, that usually only a portion of the gland is affected, and that the lower external part.

Distention of the milk-ducts does occur in puerperal mastitis, but cannot be assigned as the exciting cause of the inflammation. Roser long since pointed out that even greater distentions of the milk-ducts occur in women in whom nursing is suddenly interrupted, without leading to inflammation, and that the detention of the milk in the inflamed duct is the result, and not the cause, of the inflammation.

Billroth insisted that there must be a special irritation to produce the process of inflammation ; and we now know that it is the *infection* of the breasts by bacteria that induces the inflammation. There are apparently two avenues by which the microbes enter—the one through the *fissures and ulcers,* however small, upon the nipple ; the other through the *milk-ducts* by organisms which find their way in through the ducts or have their normal habitat in the deeper layers of the skin (Welch). Infected wounds in the genital passages may also produce metastases in the mammary glands. In most cases the inflammation remains limited to the points of original infection. The inflammatory process may reach a certain degree of intensity and then gradually subside, but more commonly it increases in severity and ends in suppura-

tion and abscess-formation. Such an abscess is known as an *antero-*, *intra-*, *retro-mammary* abscess according as it is located upon the gland, within the gland, or behind it.

The SYMPTOMS of the inflammation leading up to the abscess are pronounced. With a history of fissured nipple in a primipara we have the sudden onset of pain—perhaps a chill, with increased tenderness in one portion of the breast. The redness of the skin which occurs early in the superficial abscess appears very late in the abscess located within the gland ; and in those placed behind it there may be no redness of the skin over the breast at any time. Fluctuation also is very apparent in the superficial abscess ; it is often uncertain in the smaller deep-seated abscesses within the breast, and in those located behind it fluctuation may not be made out at all, and then only at the margin of the gland and when the abscess has already reached some size.

The **superficial mammary abscess** is located usually near the nipple. Fluctuation occurs early ; the pus is just beneath the skin, which is red and already thinned by inflammatory softening. The abscess should be opened by an incision radiating from the nipple, to inflict the least possible damage to the secreting structure of the breast. The skin should be rendered aseptic, as has been elsewhere described, and the incision so placed as to afford the best possible drainage ; at the same time it should be through the thinnest part of the inflamed surface, where the abscess would probably break if left to itself. If this last precaution be not taken, it is more than probable that an independent secondary opening will occur at this point.

Intramammary abscess is a much more serious condition, and may, in severe cases, lead to a total destruction of the function of the gland by the formation of numerous multiple abscesses and their attendant sinuses. The fluctuation is not always easily made out, the elastic pillowy feel of the breast itself adding to the difficulty of the examination. The signs of inflammation are the temperature, local tenderness, and the hardness which has existed for some days. Within a day or two softening of the area of hardness will be noticed, and within the next two or three days redness of the skin.

Many writers, following the dictum of Velpeau, advise against incision into the breast itself to open these abscesses. The claim is made that if left to open itself the abscess will do so by making its way to the surface between the lobules and ducts without destroying them, as would necessarily be the case, to some extent at least, by incision. The danger of further local and general infection, however, far outweighs any such consideration, and the incision radiating from the nipple will inflict the least possible damage to the secreting tissues. In those cases where multiple abscesses have formed throughout the gland, with burrowing sinuses from one to another and to the surface, it may become necessary to amputate the entire gland to arrest the process of suppuration. Such extreme measures ought rarely to be necessary when the early treatment of the affection has been properly carried out.

Retro- or submammary abscess is fortunately rare. It may result from an extension of an intramammary suppuration or it may occur by metastasis. The onset may be most insidious, or it may be severe, with marked evidence of general septic infection. The gland itself may be only slightly involved, and is protruded outward, resting upon a cushion of pus. Usually the pus presents itself on the lower border of the gland

in a direction determined by gravity. It may, however, point along the upper border of the gland or in the axilla, and has been known to make extensive dissections of the chest-wall, and even to break into the thorax. As soon as discovered an opening along the lower or axillary border of the gland should be made to secure the very best possible drainage. After opening any of these varieties of abscess no pressure should be made upon their walls to force out their contents, nor should they be irrigated with any watery sterilized solutions. The flow of pus may be favored by the position of the patient, and the cavity should be gently, and not too tightly, packed with iodoform gauze and a voluminous antiseptic dressing applied. This dressing usually requires renewal upon the third or the fifth day, or sooner if the temperature rises to 103° F. During all this time the breast must be efficiently supported, and no bandage equals in efficiency adhesive straps applied in the manner already described. The circular strips may be omitted in these cases, and only the long straps passing under the breast need be applied.

Chronic Mastitis.

The *chronic lobar induration* of some authors is a chronic inflammatory process involving one or more lobules and ducts of one or both breasts. The cellular infiltration between the acini and the lobules becomes organized into dense connective tissue. This contracts, destroying the acini or closing them off into retention-cysts containing a small quantity of brownish or colorless fluid. The lobule becomes nodular, irregular, and adherent to the structures adjacent. If the larger ducts are involved, retraction of the nipple may also occur. This form of chronic inflammation occurs in women who have not borne children as well as in those who have. Quite frequently it occurs in both breasts, and to some slight degree is present in women between the ages of forty and fifty. The pain is often severe and of a neuralgic character, and is frequently the first symptom that attracts the patient's attention to the breast. The fear of malignant disease and the frequent handling exaggerate the pain and suffering. The differentiation from carcinoma is often most difficult. The two conditions occur at the same age—they each form irregular hard nodules, and the nipple may be retracted in each condition. The following points are of service in making out the differential diagnosis between—

Chronic Induration.	*Carcinoma.*
Leathery hard.	Stony hard.
Increased size during menstruation.	Size usually not affected by menstruation.
Both breasts frequently affected.	Confined to one breast.
Growth very slow.	Growth rapid.
Lymphatics usually not enlarged.	Lymphatics always enlarged (late).
No cachexia.	Always cachexia (late).
Improves or remains stationary.	Grows worse.

Finally, the examination with the flat of the hand should be made : the clothing should be removed so that the breasts are entirely accessible. Before any examination is made with the fingers the palmar surface of the hand is placed flat upon the breast over the suspected spot, and with gentle pressure the lobules rolled over each other. If it be merely

chronic induration, nothing can be felt ; if a tumor be present, it comes out more distinctly. If the patient is very thin, it is possible to mistake a costal cartilage or an unusually curved rib for a new growth. This valuable aid to diagnosis does not serve to distinguish the various forms of new growth, but only to differentiate them from cases of chronic lobar inflammation. And it must be admitted that in the very beginnings of malignant disease, especially carcinoma, this method may fail. In any case of doubt, where all means of diagnosis fail, it is the duty of the surgeon to insist upon an exploratory incision, the inspection of the mass, and a microscopic examination of a specimen removed.

The TREATMENT of this condition by the administration of potassium iodide in full doses or by liquor potassæ and arsenic is highly recommended. The most useful local treatment is strapping with adhesive straps, as has been elsewhere described. This procedure makes equable pressure over the entire breast, and thus favors the absorption of the new-formed connective tissue ; at the same time the patient is prevented from handling the breasts and thus further aggravating the condition.

TUBERCULOSIS.

In common with the other organs of the human body, the mammary glands do not enjoy immunity against the ravages of the bacillus of tuberculosis. They are, however, not so commonly affected with tuberculosis as would seem probable on account of their exposed situation and their intimate vascular relations with the body proper. No doubt tuberculosis of the breast is more common than seems at first apparent, for many cases of so-called *chronic mastitis, chronic mammary abscess,* and *mammary fistula* are the results of tubercular disease, and certainly the affections described as *scrofulous tumor* and as *cold abscess* belong to this category. As a secondary disease tuberculosis of the breast may follow upon a tubercular empyema or ostitis of the ribs, in which infection by contiguity of structures occurs. The *chronic mammary fistula* of certain authors is usually the result of a secondary tubercular disease in the breast consequent upon a primary infection of the adjacent pleural sac or ribs. Metastatic mammary tuberculosis, in which the infectious material obtains access to the breast through the vascular channels from a tubercular focus situated in some distant portion of the body is a possibility, though it is surprising when we think how rarely disease of the breast occurs, even in extensive or general tubercular disease of other organs. In primary tuberculosis of the breast the tubercle bacillus must find its way into the organ through the same natural route chosen by other infective micro-organisms —that is, through the milk-ducts. Primary infection may also be possible through the avenue of an open wound upon the breast or nipple.

Tuberculosis pursues the same course in the breast that marks its progress in other soft structures of the body (Vol. I. p. 174).

The histological lesions are identical with those characterizing this form of granuloma, and the gross lesions deviate in no way from the usual types. Miliary tuberculosis can scarcely be defined from actual observation, for when encountered clinically the tubercles have usually passed into more or less caseous masses, which may be spread diffusely throughout the glands or become confluent as one or several large circumscribed nodes. The nodules of diffuse tuberculosis vary in size and number. They are usually accompanied by a low grade of inflammatory action in the tissues surrounding them, so that the portion of the organ affected by the disease becomes both nodular and indurated. Cheesy degeneration of the tubercular nodules occurs in due time. Sooner or later the retrograde changes in the tubercular lesion lead

to liquefaction of the caseous contents of the nodules, and the softened material thus formed burrows throughout the gland and eventually finds its way to the surface. In this way a series of *discharging sinuses* may be produced which riddle the breast in various directions. This fate is shared alike by the diffused and circumscribed tubercular lesions. Spontaneous healing has been noted in mammary tuberculosis in which the foci were small in number and of moderate size. Encapsulation by a protective connective-tissue barrier and absorption or calcification of the inner tubercular material affect the healing process. This method of termination is the exception, and the tubercular breast becomes an ever-present source of danger of general tubercular infection. Of the surrounding structures, the contiguous lymphatic nodes are usually infected from tuberculosis of the breast. Tuberculosis, like most other diseases of the mammæ, attacks the gland by preference during the period of functional activity, and it thus happens that puberty, pregnancy, and the puerperium are the occasions most commonly chosen.

DIAGNOSIS.—While by no means a common affection, the possibility of tuberculosis of the breast must not be lost sight of by the surgeon, and obscure chronic inflammatory or suppurative conditions, or circumscribed and multiple nodes lacking the features of ordinary tumors, especially if accompanied by anæmia, emaciation, and a typical fever, should arouse suspicions of the disease. Before the foci have softened a diagnosis is often extremely difficult, especially in the case of the larger single tubercular masses, in which the involvement of the axillary lymphatics strongly suggests cancer. After softening of the lesions has occurred, and particularly after an external opening and multiple internal sinuses have established themselves, the diagnosis of tuberculosis becomes a much easier matter.

From the ordinary pyogenic infections tuberculosis can usually be differentiated by the history of a sudden onset and the acute inflammatory symptoms of the disease, together with a microscopical and bacteriological examination of the exudate, in which the pus-cells and the pyogenic cocci of acute infections will usually be found. Syphilitic gummata in the breast may very easily be mistaken for a circumscribed tuberculosis, but here the specific history or the negative results of thorough antisyphilitic treatment will clear the doubt.

The **differentiation** of tubercular disease from the ordinary tumors of the breast is usually readily accomplished when the various characteristics of mammary neoplasms are brought to mind. In all cases of doubt, however, a positive diagnosis of tuberculosis can be made by the microscopical or bacteriological methods or by both combined. A microscopic examination of the fluid exudate obtained from the discharging sinuses or by exploratory puncture will reveal the granular débris and lack of formed elements distinctive of tubercular pus. Preparations of the exudate stained by the ordinary methods for the tubercular bacilli may reveal these organisms. Finally, the inoculation of a susceptible animal, preferably a guinea-pig, with the suspected fluid will usually reveal the presence of the tubercle bacillus by reproducing the disease in the animal, even though all other methods of examination are negative. Even in those cases of mixed infection or secondary infection in which a pyogenic and tubercular infection occur together, and in which no suspicion of tubercular trouble would be obtained by the usual microscopical or bacteriological examinations, the inoculation test would still be available. In cases in which the suspected masses were still solid a piece of tissue could be removed with aseptic precautions and employed for inoculation experiments and for histological study.

TREATMENT.—Thus far, we have no specific treatment for tuberculosis, and this disease resists all of our therapeutic measures in much

the same way as cancer does. A focus of tubercular disease, like a tuberculous breast, constantly threatens the life of its possessor, since secondary disease in remote parts may spring from it at any time : there seems, therefore, to be but one rational method of treatment at present indicated in all accessible tubercular foci—viz. complete removal of the diseased tissues. In the breast this means the amputation of the diseased organ and the removal of infected lymph-nodes and other diseased tissue by substantially the same method as will be recommended for the removal of a carcinomatous breast.

Syphilis of the Breast.

Syphilis is not necessarily a venereal disease. The breasts, next to the lips and mouth, are perhaps most frequently the seat of the initial lesion in non-venereal chancre. In one mode of infection the virus is carried from the syphilitic infant through fissures and abrasions of the nipple to the mother or wet-nurse. Various unique and unusual sources are given in the literature. The *chancre*, however acquired, takes on the characteristic indurated, circular, punched-out appearance of the specific venereal sore. "It is a bold surgeon," says Mr. Hutchinson, "who makes the diagnosis of hard chancre before the secondary symptoms appear." If this be true of the diagnosis of venereal sores, how much more of those which occur in unusual localities! The indurated, circular, non-healing ulcer, together with the enlarged, superficial axillary and clavicular nodes, will arouse a strong suspicion of its true character, and the appearance of the specific secondary eruption will dispel all further doubt. In syphilis the superficial lymphatics of the axilla and the clavicle become enlarged at the same time. In carcinoma it is the deeper lymphatics in the axilla which first become enlarged, and those in the clavicular region much later.

Secondary syphilis occurs upon the breast in the form of skin eruptions and mucous patches.

The DIAGNOSIS is usually readily made in these specific skin eruptions, as they are present in similar forms upon other parts of the body at the same time. Syphilitic mucous patches sometimes form upon the inferior surfaces of the pendulous breasts of fleshy women. The anæsthesia and analgesia occasionally observed in the breast are regarded by Fournier as manifestations of later secondary syphilis.

The *tertiary syphilitic diseases* include rupia, ecthyma, mucous patches, and gummata. Gumma is located either subcutaneously or within the breast, and may be either diffused or circumscribed. The circumscribed gumma, far more frequently than the diffuse, develops without much or any pain, and is often discovered by accident. The gumma gradually increases in size, becomes adherent to the skin, which in turn is reddened, softened, and finally gives way, and the contents of the gumma discharged. Healing usually takes place promptly. The remaining scar has a characteristic deep copper-colored stain. Great difficulty in the diagnoses of tertiary syphilitic affections, especially gumma from malignant tumor, often arises, and no doubt gummatous breasts have been removed under the mistaken idea that they were cancerous. The lesions of syphilis are usually multiple; the initial lesion of cancer is single. Syphilitic affections are commonly very

chronic in their history, and improve rapidly under vigorous anti-syphilitic treatment. Carcinoma, on the other hand, is progressive, shows no tendency to recover, and does not improve under antisyphilitic treatment.

TREATMENT.—Syphilis is the most amenable to treatment of all the chronic diseases. Mercury by inunction, or gray powder in grain doses, is recommended by Mr. Hutchinson. Iron and arsenic with the mercury, in the anæmic and feeble, is the treatment to be followed in the secondary stage. In the tertiary stage mercurial inunctions and iodide of potassium in increasing doses, combined with essence of pepsin or bitter tonics, continued for a length of time, give the best result.

NEURALGIA OF THE MAMMÆ; MASTODYNIA.

A painful affection of the breast occurring, according to Gross, most frequently in young unmarried women from puberty to twenty, though it may occur at any time after puberty. The pain is often most violent and out of all proportion to the local condition which may be found present. Indeed, some of the most severe cases have occurred in women in whom no tumor or other cause for the pain could be discovered, even when the breast was explored by incision. The affection usually occurs in women who have had some pelvic disturbance and are of a hysterical type. In certain cases, however, small tumors may be felt, and Velpeau makes a classification of painful breast, as follows: (1) Neurotic tumors and nodosities; (2) Neuralgic pains without tumors; (3) Imaginary tumors.

In cases where painful nodosities occur the pain is out of all proportion to the size of the tumor, nor is the pain constant in this or any of the varieties of masto-dynia, but *periodical*, occurring either at certain periods of the day or, as often happens, just before and during menstruation. The cases in which there are severe neuralgic pains without any tumor are the most numerous. The pain often radiates into the arm and down along the sides of the thorax. According to Billroth, Eulenberg, and others, this affection is an intercostal neuralgia with radiation toward the anterior part of the thorax.

The TREATMENT of mastodynia, especially those cases in which no tumor is present, is most unsatisfactory. So far, it can only be said that the pain in some cases diminishes greatly and disappears with the cessation of the menses. Any disturbance or disease of the pelvic organs should be looked to and corrected if possible. Local application of lotions, salves, and the like are not to be recommended. A very useful practice, in severe cases, is strapping of the breasts with adhesive plaster. Not only does this produce equable pressure upon the breasts, and thus relieve the pain, but prevents the patient from applying dirty salves and from handling the breast, and thus aggravating the condition.

HYPERTROPHY.

Hypertrophy of the breast is a very rare form of enlargement of this gland. In nearly all the cases observed it has affected both breasts, and has occurred in young women, one case at the age of fourteen years. There seems no well-defined cause for the enlargement. The hypertrophy begins with menstruation; the growth is very rapid during the

first few months, and after that is very slow. The increase in volume takes place in all parts of the breast, and is a diffuse hypertrophy of the normal glandular and fibrous connective tissues of the breast. The weight becomes a burden, incapacitating the patient from work, and by the excessive nutritive activity taking place in the gland the general nutrition is bad. Pregnancy seems, in one case at least, to have had a favorable action upon the growth, arresting it, and a decided diminution in the volume of the breast was noted. No known remedy nor method of treatment has any appreciable effect to arrest or prevent the process, although a multitude of remedies, reasonable and ridiculous, have been suggested and tried in this condition.

Tumors of the Breast.

Nearly all varieties of tumor occur in the breast, not only in simple structural types, but also as mixed tumors; thus, a glandular tumor may be composed very largely of fibrous tissue as well as glandular elements, and is then known as a fibro-adenoma. In this tumor may develop cysts in the course of cystic degeneration, and it is then designated as a fibro-cysto-adenoma. Degenerations are much more common in *malignant tumors*, particularly the sarcomata; thus we have cysto-sarcoma as the result of cystic degeneration or melano-sarcoma as the result of pigmentary degeneration. Williams finds that nearly one-fifth of all tumors, both innocent and malignant, occur in the breasts, and that one-fourth of all carcinomatous tumors have their initial seat in these glands, and still further it may be stated that 92 per cent. of all breast-tumors are cancers. The word *cancer* is here used as elsewhere in this article in its clinical significance, as equivalent to malignancy, without reference to the particular variety of malignant tumor.

Cysts number less than 2 per cent. of all tumors found in the breast. They occur as both single and multiple tumors, and quite frequently are found in both breasts. They contain serous, mucous, often brownish fluid, often milk more or less changed. Others contain a clear lymph fluid, and a rare form of cysts are the hydatids. Cysts vary in size, from those containing but a few drops of fluid to those containing a pint or more. As a rule, however, the cysts of the breast only exceptionally reach such dimensions. True cysts of the breast may be divided into— first, *retention* or glandular; second, *lymphatic;* third, *hydatid* cysts. The greater number belong to the first class, the retention-cysts. The lymph-cysts are very rare—only some 16 or 20 cases were lately collected —while hydatid cysts are even more rare.

Retention-cysts are due to obstruction to the ducts or secreting acini, caused by imperfect development of the ducts, injury and disease of the nipple, or inflammation about the ducts and their subsequent contraction. The obstruction is not always complete, as often a quantity of cystic fluid can be squeezed out of the nipple. Retention-cysts are often classified, according to their contents, into (*a*) *serous, mucous, sanguino-lent cysts;* (*b*) *lacteal* or *galacteal*, occurring during lactation or afterward, containing milk more or less changed, resembling butter and oily substances.

These cysts produce no special pain or other unpleasant symptoms, but from their presence give rise to great uneasiness on the part of the patient through dread of carcinoma. No doubt, cystic breasts have been sacrificed under a mistaken diagnosis of malignancy, for it is not always possible to make a correct diagnosis from the symptoms above. Fluctuation is not usually present, owing to the tension and thickness of the cyst-walls and the depth within the breast at which it is placed. No fluid can ordinarily be pressed out of the nipple, and, to still further add to the difficulties of diagnosis, the nipple is occasionally retracted and the axillary nodes enlarged, as noted by Paget. The first appearance of the tumors at or following lactation, the fact that they are multiple and present in *both breasts*, and remembering that the nipple is not nearly so frequently retracted in cysts as in cancer, or the axillary nodes enlarged, the skin not adherent, the tumor movable, and the growth slow, all point to non-malignant tumor, and the elasticity would suggest fluid. An exploratory puncture will be necessary to make the diagnosis absolutely certain. On the other hand, the diagnosis is comparatively easy in the larger single cysts placed near the nipple or superficially, when the sense of fluctuation can be made out more or less distinctly.

The TREATMENT in these cases is to evacuate, incise the cyst under aseptic precautions, and pack the cavity lightly with iodoform gauze. When the cysts are

FIG. 248.
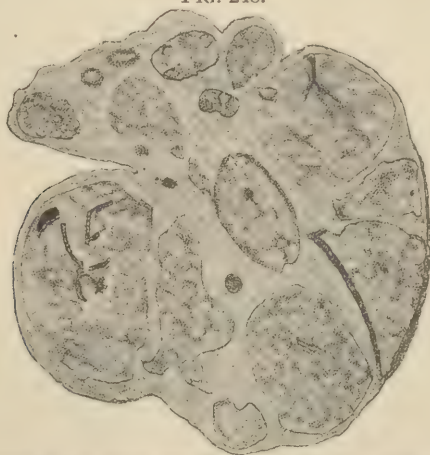
Transection of an adenoma of the breast removed from a woman twenty-two years old, showing the well-defined capsule, the fibrous stroma, and the foci of proliferated glandular tissue, varying in size, and surrounded by distinct walls of stroma which form compartments (from the gross specimen preserved in formalin solution, natural size).

very small and numerous it is needless to say they should not be disturbed. If they enlarge and the mass of the breast become an annoyance, amputation in such cases would be indicated.

Adenoma or glandular tumor (the "chronic mammary tumor" of Sir Astley Cooper) develops in the breast usually after puberty. This neoplasm differs from hypertrophy mainly in the fact that it affects single lobules or portion of lobules, and not the entire breast (Fig. 248).

By reference to the figure it will be seen that the tumor has a distinct capsule, and within is seen the tumor-tissue still retaining the outlines of the lobules. The microscopic characteristics of this tumor are well shown in Fig. 249, taken from a section of Fig. 248. The tumor is seen to consist of a fibrous connective-tissue stroma enveloping the glandular elements. In this particular specimen the amount of fibrous connective tissue is excessive. Tumors showing a larger amount of cellular elements are known as acinous adenoma when the cells of the acini predominate, and a tubular adenoma when, on the other hand, the cells from the ducts are in excess. When the fibrous stroma is in excess of the glandular elements, as

is most frequently the case and as the drawing shows, it is known as a fibro-adenoma. Not infrequently the acini and the ducts are dilated into cysts of various sizes; such a tumor is known as a cysto-adenoma.

Adenoma is rarely observed before puberty or after the menopause. These tumors seem, therefore, to develop during the functional activities of the organs. The growth is usually slow and painless. The tumor

FIG. 249.

A section of the adenoma shown in Fig. 248, taken from the border of one of the glandular foci, showing the dense connective-tissue stroma, and the glandular tubules lined with several layers of epithelial cells and cut in various directions. A few small blood-vessels in cross-section are also apparent. (Tissue fixed in formalin solution; section stained with formalin methyline blue. Leitz, obj. 3, ocular 4 (A. P. Ohlmacher).)

has a hard, bossy feel, often nodulated. Owing to its great tendency to cystic degeneration it often has an elastic, semi-fluctuating feel. The tumor has a capsule and is thus freely movable.

The chief DIAGNOSTIC SIGNS of adenoma are its hard, nodular feel, slow growth, mobility within the breast, not adherent to the skin, no retraction of the nipple or enlarged lymph-nodes, a slight discharge at nipple upon squeezing the breast, and the patient about thirty.

Sarcomata are rare as compared with carcinoma, forming but 7 per cent., and carcinomata 85 per cent. of the malignant tumors of the breast. The round, the spindle, and even the giant-celled sarcomata have been observed as occurring in this gland. More frequently the sarcoma-cells invade a fibroma or adenoma and form a fibro-sarcoma or adeno-sarcoma, or, infiltrated with pigment-cells, a melano-sarcoma. These mixed-celled sarcomata frequently undergo cystic degeneration, and are then known as fibro-cysto-sarcomata. Sarcoma rarely occurs before puberty or after thirty. The tumor becomes voluminous, though the growth at first may be slow. The skin is stretched and shiny, of a dark reddish-brown color with blue veins showing through. The entire gland may be involved in the growth, the so-called *sarcoma en masse*, or the tumor may develop in certain parts of the gland at about the same time. In

the former case the tumor is uniform and the skin stretched smoothly over it; in the other the numerous points of growth give a nodular character to the breast.

Sarcomata have been mistaken for abscess, owing to the redness, rapid growth, sense of fluctuation, and pain attendant upon the growth, and have been punctured under the supposition that they were abscesses. The history of a recent pregnancy or lactation, the rise of temperature, and distinct fluctuation point to abscess-formation. In making the examination it is well to remember Colles' law, that the wider the area over which fluctuation can be felt the more certain is the presence of fluid. But in case of doubt an exploratory puncture will reveal the true character of the mass. From carcinoma the distinction is still more difficult, and the microscope must in many cases determine the exact character.

Age.—Sarcomata occur usually before thirty; carcinomata are rare before thirty. The skin is stretched, shiny, and reddened, and not early adherent to the sarcoma. In carcinoma the skin is early infiltrated and adherent, pale, blanched, and puckered. Axillary nodes are not enlarged in sarcoma: there is always an early enlargement in carcinoma. In the cut section of a sarcoma there is an absence of adipose tissue, this having been transformed into sarcomatous tissue. In carcinoma there is always considerable fatty tissue present (Cornil and Ranvier).

Carcinoma of the breast occurs under two histological forms—*acinous* and *tubular*, according as the primary growth develops in the acini or tubules. (*Vide* Carcinoma, Chapter XXVI. Vol. I.) In the acinous variety the carcinoma cells are closely packed in the alveolar spaces and

Fig. 250.

A scirrhous carcinoma of the male breast of one year's duration, removed from a patient fifty-one years of age. Photograph of gross alcoholic specimen somewhat reduced in size. At *a* the shrunken and retracted nipple; the dark-colored area *b* represents the ulcerating surface of the tumor; while *c* marks the incision made for obtaining tissue for microscopical examination.

surrounded by a connective-tissue stroma. The cells are large, irregular, spheroidal, and multinuclear, showing a large amount of granular matter within the cell-body and frequent mytoses in the nuclei of the cells.

The amount of stroma forming the alveolar spaces and the rapidity of the growth of the tumor determine the clinical variety. If, as is most frequently the case in carcinoma of the breast, there be an abundance of stroma and a slower growth, the tumor is known as a scirrhous, hard, or chronic carcinoma. If, on the other hand the tumor develop rapidly, with a small amount of alveolar stroma and an excessive proliferation of the cells, the tumor will have a soft, elastic feel, and is known as encephaloid, soft, or acute carcinoma (Fig. 252). Carcinoma cells, and the stroma as well, are subject to colloid degeneration: when this occurs the tumor is known as a colloid carcinoma. This form of degeneration most frequently follows in the soft or acute carcinoma.

Tubular carcinoma occurs much less frequently than the acinous variety, and develops from the tubules or excretory milk-ducts.

Injury or inflammation of the ducts or the degeneration of a cyst-wall is frequently the origin of a tubular carcinoma.

Fig. 251.
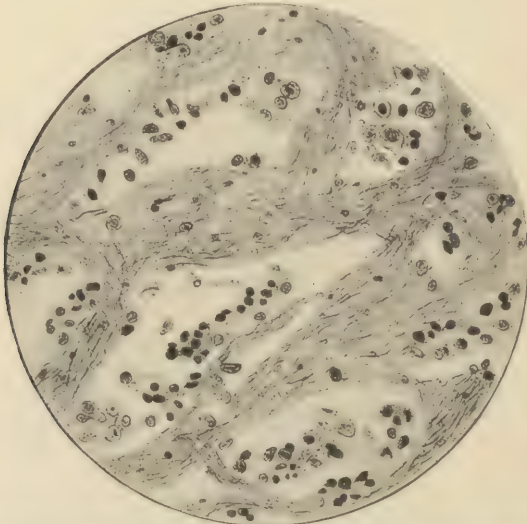
A section from the tumor shown in Fig. 250, showing the large amount of dense connective-tissue stroma surrounding the irregular islets of epithelial (carcinomatous) cells. An actual necrotic destruction of the epithelial cells is taking place. The protective and inhibitory influence of the connective-tissue overgrowth occasionally seen in scirrhous carcinomata was shown in this case by the slow growth of the tumor and by the absence of metastases in the axillary lymph-nodes of the affected side. (Tissue fixed in formalin solution; section stained with formalin-safranin. Leitz, obj. 7, ocular 4.)

SYMPTOMS OF CARCINOMA.—The "scirrhous" variety is by far the most frequent, and usually begins in a hard nodule located in the periphery of the breast. Statistics seem to prove that the largest proportion develop in the upper outer quadrant of the breast. The next most usual position is about and below the nipple and areola. Apparently the left breast is more often affected than the right; but what is of much more importance is the fact that in only 2 cases out of 869 were both breasts simultaneously affected with beginning carcinoma. When any neoplasm, therefore, develops in both breasts at the same time, there is very strong evidence that it is not carcinoma. The primary nodule of carcinoma is often discovered accidentally by the patient in the bath or while she is dressing. Pain, which sooner or later becomes a distressing symptom of all forms of carcinoma, is often entirely absent in its earlier stages.

When the nodule is once discovered, the patient, overcome with a dread of cancer, often complains of pain in the seat of the tumor where just previously none had existed.

The growth of carcinoma is rapid compared with that of benign tumors. A carcinoma grows perceptibly in from three to six months. The volume of the tumor is, however, not great: in scirrhous and colloid carcinoma, in fact, the bulk of the tumor is often less than the portion of the breast displaced by the tumor. In the growth of carcinoma there is a twofold cellular proliferation—(1) the multiplication of carcinoma-cells within the alveolar spaces; and (2) the area of small-celled infiltration at the growing margins of the tumor. These latter cells resemble embryonic connective-tissue cells, and form a considerable proportion of the bulk of the tumor.

By this **infiltration of the tissue** with young cells the tumor becomes fixed and immovable. This *fixation* is an early and important sign of

FIG. 252.
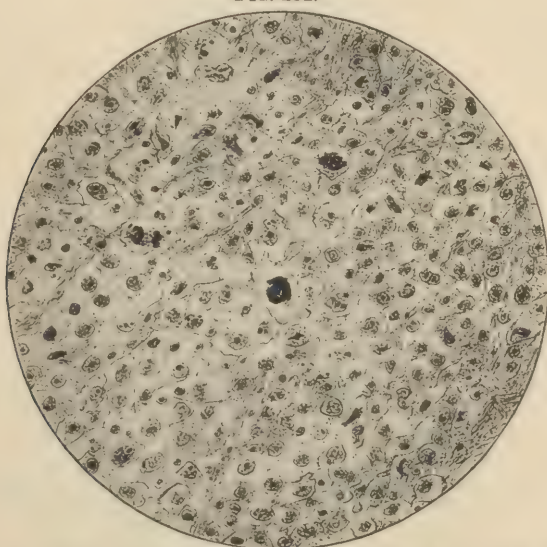
A small portion of a section of a rapidly-growing soft carcinoma of the breast of a woman forty-seven years of age—the so-called "acinous carcinoma" of Billroth—showing the great abundance of polymorphous epithelial (carcinomatous) cells, with the very sparing amount of connective-tissue stroma. In three of the carcinomatous cells karyokinetic nuclear figures are prominent as dark masses. (Tissue fixed in Flemming's chromic-acetic-osmic-acid mixture; section stained with Pfitzner's safranin solution. Leitz, objective 7, ocular 4.)

carcinoma. It is a fixation of the *tumor itself,* and any mobility made out by manipulation of the tumor is a motion of the whole breast, and not of the tumor moving within the breast. Coincident with the cellular growth of the carcinoma a degeneration of the cells within the alveoli occurs, with the retraction of the connective-tissue stroma. This tendency to contraction occurs very early in carcinoma, and when the initial lesion is seated in the superficial portion of the breast there is a marked *retraction and dimpling of the skin* (pig-skin appearance). This is not due primarily to the infiltration of the skin by carcinoma-cells, but rather to the contracting tendency of the tumor, drawing in the *ligamenta suspensoria.* In nearly 50 per cent. of all carcinomata the nipple is retracted and drawn in by the contraction of the connective-

tissue stroma about the milk-ducts. Thus, carcinomata developing in and about the nipple are much more liable to produce this symptom than those placed remotely at the periphery of the gland. As retraction of the nipple rarely occurs in non-carcinomatous conditions (5 per cent., according to Gross), this symptom becomes of importance in determining the malignancy of the growth when it is present. But as it is not the earliest symptom, and may be absent altogether, and does occur in conditions other than cancer, it is not as important a sign of carcinoma as is generally supposed. Somewhat later the skin becomes adherent to and infiltrated with the carcinomatous elements. This adherent, retracted, pale, and dimpled skin is a very important symptom of cancer.

Fig. 253.

Advanced scirrhous carcinoma of eleven years' duration in a woman of sixty years. A superficial ulcerating process has begun in the skin overlying the tumor, and a considerable bulk of the protruding tumor is composed of a fluctuating mass of puruloid material ready to break through the surface. The axillary nodes are extensively involved.

Carcinoma often disseminates itself most rapidly through the lymphatic vessels of the skin. The points of secondary deposits appear as small hard, shot-like nodules in the skin. These nodules rapidly develop —so rapidly, indeed, that the skin assumes a dusky red, inflamed appearance, and coalesces into a flat plate-like mass, the *squirrhe en masse* of Velpeau. Not only does the carcinoma involve the skin, but it becomes adherent to all the adjacent tissues. In certain cases the entire chestwall is so infiltrated with the carcinoma-cells that it is hard and boardlike, and the ribs so fixed that the respiratory movements on that side are interfered with. Velpeau gave to this particular form the name of *cancer en cuirasse*. It is not to be regarded as a separate variety of carcinoma, as has been done by some writers (Fig. 253).

The **atrophic cancer** of Billroth is not a distinct variety. A degeneration of the alveolar cells takes place early in all carcinomata. In scirrhous or chronic carcinomata, in which the growth of the tumor is relatively slow, there is ample time for an amount of absorption of this material as well as connective-tissue organization, and the alveolar spaces become filled with whorls of connective tissue. Usually the tumor is advancing at some other point while these atrophic changes are taking place, so that it is not by any means true that carcinoma is a self-limited disease and effects a spontaneous cure in this manner.

FIG. 254.

Same as Fig. 253.

The writer saw at the London Hospital a woman in whom such atrophic changes had been taking place for eighteen years. All outline of the breast had long since disappeared, together with the nipple and areola, and only a hard, brown, leathery mass, firmly adherent to the ribs, remained. Successive visiting surgeons from the time of Mr. Curling and the elder Adams had proposed operation, which had been resolutely declined, and she was when seen earning her living as a laundress.

The Lymphatics.—The lymph-nodes are very early involved : those of the axilla are usually the first to be affected in carcinoma of the breast. The axillary nodes have been found enlarged and containing secondary carcinomatous deposits in every case where the axilla has been thoroughly explored in the operations upon the breast. They may be so small that it is impossible to detect them before the operation, but their presence will be revealed during the dissection. The lymphatics may be enlarged from simple irritation or inflammation, but in such cases may be felt as separate, distinct nodules. Lymph-nodes containing secondary carcinomatous deposits are very hard, matted together,

and indistinguishable from each other. In carcinomata located on the sternal side of the breast the secondary deposits would first appear in the mediastinal nodes, a condition which can only be surmised. When the tumor is placed near the nipple not only the axillary nodes, but the infraclavicular, are early involved. Dr. Halsted finds that in nearly all cases where he has removed the supraclavicular fat and lymphatics a microscopic examination has shown the presence of carcinomatous cells.

On making with a knife a section of suspected tissues which have been preserved in alcohol or 2 per cent. formalin solution, the cancer-tissue, if present, appears blanched and white, in marked contrast to the surrounding tissues.

DIAGNOSIS.—The first question to which an answer must be given in a case of tumor of the breast is, *Is it innocent or malignant?* The fol-

FIG. 255.

Recurrent carcinoma eight months after incomplete operation in a woman seventy-five years of age, showing the extensive nodular, ulcerating surface surrounded by cancerous masses under the skin. The œdema of the right arm from the circulatory obstruction occasioned by metastatic growths about the axillary vessels is well shown.

lowing are among the most important points to be considered in arriving at a differential diagnosis: *Age.*—Innocent tumors appear at any age, as do the malignant neoplasms, but innocent tumors are more apt to occur at puberty and during pregnancy and lactation. Of the malignant tumors, sarcoma occurs before thirty; carcinoma, which is the most common tumor of the breast, is very rare before twenty-five, not common before thirty-five, and most common from forty to fifty. This is known as the *cancer period*. *Skin.*—Innocent tumors do not become adherent to the skin (unless the tumor undergoes some degeneration or inflammation, which is most unusual). Malignant tumors involve the

skin early. Either the skin becomes stretched, shiny, red, and brawny, with large veins showing upon its surface, as in sarcoma, or it is retracted, pale, and pitted, as in carcinoma. *Growth.*—The growth of an innocent tumor is always slow, pushing aside the normal tissues, from which it is separated by its capsule. The growth of a malignant tumor is rapid, infiltrating the tissues without any capsule or limiting membrane. *Mobility.*—Innocent tumors are usually freely movable, owing to their capsule and method of growth. Malignant tumors early become fixed and immovable (there is often an apparent mobility in carcinoma which is not real), and tumors which seemed movable on examination are often at the operation found firmly adherent to the subjacent tissues.

Pain.—Innocent tumors are not usually painful; pain becomes, sooner or later, a prominent symptom in all cases of cancer. The pain, being a subjective symptom, must be taken with great caution. The patient upon discovering a lump in the breast usually experiences some pain from that moment, although there has been no pain before, and with every evidence that the mass had been there for some time. There may be no pain in the earlier stages of a malignant tumor, but to wait for the appearance of pain as an essential sign of cancer would be to permit the period in which the patient could be saved by operation to slip away.

Fig. 256.

Cancer of male breast (Park).

Secondary affections do not occur in the growth of innocent tumors, while they always occur, and usually very early, in all malignant tumors. When lymphatic enlargement does occur in connection with the growth of innocent tumors, it is the nature of an hypertrophy of the normal cellular elements, and not a heterologous new growth, as takes place in malignant growth. The hypertrophied nodes may be felt separate and movable, while those containing cancerous deposits are matted together and feel hard and nodular.

Metastasis.—Innocent tumors never form secondary deposits in other organs. Malignant growths do form such deposits very frequently; most important, however, is the fact that these metastases in other organs may occur very early in the development of the tumor, and are not infrequently cause of death, even after the most careful and complete local removal of the growth.

Cachexia.—Innocent tumors do not affect the general health, except mechanically. With the growth of malignant tumors cachexia is always developed.

By attention to these different points the question of malignancy or non-malignancy may be determined in many cases. But in the very early stages of cancer, when the tumor is small, before the skin has become adherent over the tumor or the axillary nodes enlarged, or pain or evidence of rapid growth can aid in the

differential diagnosis, and the age of the patient under forty,—in such cases it is impossible by the symptoms alone to make the diagnosis certain. To affirm that in all such cases the breast should be removed would be to sacrifice breasts which could be saved. As the microscopic examination is, after all, the final test of the character of the growth, it is far better to make this examination before the removal. The microscopist must be competent and conservative, as well as the surgeon; and if one examination is not satisfactory, a second trial specimen should be secured and examined. The instruments which have been devised by various operators in the form of harpoons, hooks, and punches to secure a trial-piece of the tumor are quite inadequate. The fragment obtained by such means is insufficient to examine the cells in their relations, and the operator can never know that he has secured a piece of the growth itself. It is far better to make an exploratory incision into the doubtful growth, examine the cut edge macroscopically, and secure a piece, including the growing edge, large enough to make sections. This preliminary operation may be done under general or local anæsthesia. Complete local anæsthesia can be secured by following the method of Dr. C. L. Schleich. This consists of injecting into the true skin a solution of cocaine, composed of cocaine hydrochlorate gr. jss; morphine hydrochlorate, gr. 1.8; sodium chloride, gr. 3; sterilized water, ℥iij. The needle is introduced into the true skin at the desired point and a small quantity of this solution injected. The needle is withdrawn and introduced again, obliquely through the edge of this now anæsthetic area, and a second circle of anæsthesia is formed. When a sufficient superficial area has been rendered anæsthetic the needle is introduced into the deeper tissues, and even into the tumor itself, and the tissues injected full of the fluid. By this method, carefully carried out, complete anæsthesia is secured and the exploratory incision and the section removed without pain to the patient.

OPERATIONS UPON THE BREAST.

As in every surgical operation, the patient, the operator, his assistants, instruments, and dressings should be prepared in accordance with the principles of the most rigid asepsis. These details, having been

FIG. 257.
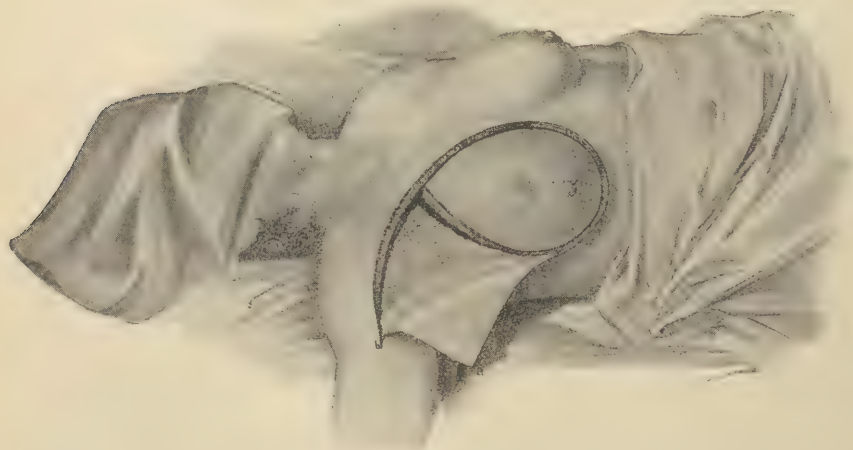
Diagram showing skin-incisions: triangular flap of skin, *ABC*, and triangular flap of fat (Halsted).

repeatedly given in other portions of this work, are omitted here. As the hair of the patient's head is often the source of wound-infection, the head should be enveloped in a moist bichloride towel-turban, and a sterilized sheet thrown over the face and neck and fastened to the apron

of the anæsthetizer, and the anæsthetic administered beneath this. The arm on the affected side is drawn well outward and upward, enveloped in sterilized towels, and given over to an assistant. The thorax and portions of the body not in the field of operation are to be protected by a mackintosh covered with sterilized towels. As the anæsthetic has to be given under a sheet and maintained for a long time, ether, when not contraindicated by organic disease of the kidneys or lungs, should be administered. Some experiments in the use of chloroform combined with pure oxygen have proved it to be a very satisfactory combination. The patients are brought under the anæsthetic in from six to ten minutes; the anæsthesia is easily maintained—no vomiting, no

FIG. 258.
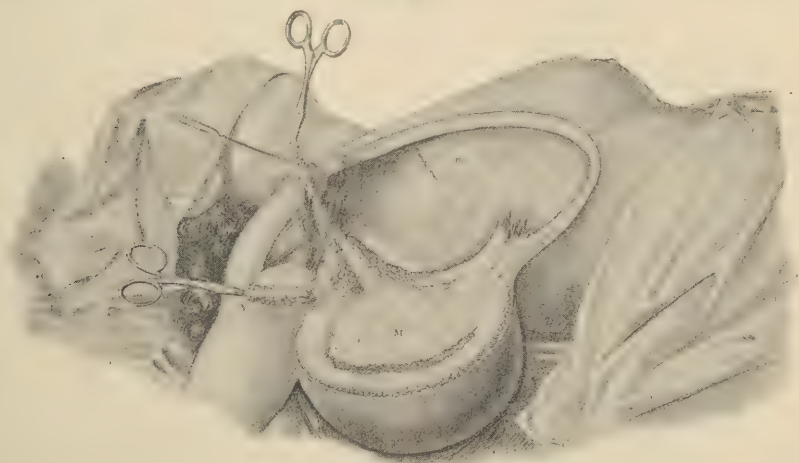
Breast and pectoral muscle completely separated from thorax; axilla exposed (Halsted).

dangerous interruptions to respiration or heart or pulse, no cyanosis, diminished shock, and patient recovers from the anæsthetic state without delirium.

The Operation on Innocent Tumors.—The character of the operation will depend somewhat upon the position and number of innocent tumors present. If the tumor is single and situated within the gland, the incision should be made along the groove at the lower border of the breast. The gland is raised and the capsule of the tumor opened, and the tumor enucleated, the breast replaced, and the wound closed with fine marginal silk suture. In some cases a narrow gauze drain for a few days may be necessary. If the tumor is located in the upper, outer quadrant of the breast, the incision may be made along the pectoral muscle and the breast raised and the tumor removed. By this method of Thomas there is the least injury inflicted upon the secreting structures and the avoidance of a prominent scar on the breast. If the tumor is very superficial, as lipoma, or so placed that it cannot be reached without too extensive disturbance of its anatomical attachment, a straight or curved incision may be made directly down upon the tumor and its removal effected.

OPERATIONS ON MALIGNANT TUMORS.

Distinct advance in the surgical treatment of malignant growths has been secured by the earlier and more complete removal of the primary tumor and all the infected tissues. The opening of the axilla in every operation for malignant disease of the breast marks a most distinct advance in their treatment. The removal of the supraclavicular lymphatics and fat, as suggested and practised by Dr. Halsted in suitable cases, is another step in the direction of completeness. The practice of Volkmann of removing the infected pectoral fascia gave him the best results of his time, and, with few exceptions, of all time. The removal of the greater portion of the pectoral muscles with their fascia, and the removal of the supraclavicular nodes and fat, together with a thorough removal of the contents of the axilla, have given the very best results obtained.

No operation upon the breast can be too extensive if infected material remains to be removed, and as the operation described by Dr. Halsted is the most complete and extensive, we shall give, in substance, an outline of the steps of the operation as he performs it : The external incision (see Fig. 257) extends in a wide curve from the middle of the upper portion of the arm out over the chest and edge of the sternum well beneath the nipple, and upward, following the curve of the breast to meet the first incision. This incision should be carried at once through the skin and superficial fat. The triangular flap, *a b c*, of skin, free from all fat, is dissected down to the inferior border of the pectoralis major muscle. The separation of the pectoralis major muscle from its costal origin is now begun and carried upward, the costal portion being separated from the clavicular out to the apex of the axillary cavity. At this point an incision is carried up to the clavicle through the muscle and skin, exposing thus the apex of the axilla. Any fascia made accessible upon the under surface of the pectoralis major is now carefully dissected away. The pectoralis major is next severed from its humeral attachment and reflected with the breast-mass. The fascia over the pectoralis minor is dissected away, and this muscle divided in its middle and reflected back and held by a broad blunt retractor. The axillary vessels are exposed and carefully separated from the mass of fat and nodes occupying the space, commencing at the very apex and working downward, and continuing the dissection to the subscapular vessels. Every particle of fat and fascia is to be removed.

During the various steps of the dissection hæmostats should be used freely, grasping each end of a vessel as it is severed, or, better, severing the exposed vessel between two hæmostats. The delicate vessels within the axilla, branches of the artery and vein, are to be ligated at once with silk, care being taken not to include any fat within the knot. Every care should be taken throughout the operation to prevent loss of blood. The operation is completed by severing the fat along the base of the skin-flap first raised. By this method the entire breast, fat and lymphatics, fascia and muscles, are removed in one mass. No incision is made into the cancerous growth itself or into the lymphatics, and the ever-present danger of inoculation by the liberation of cancer-cells is obviated.

The next step in the operation is to remove the supraclavicular fat and lymphatics. This may not be absolutely necessary in those cases which are operated very early, before the axillary lymphatics are involved. But most cases do not come to the surgeon until a much later period, and it will be, with suitable exceptions, a safe rule to follow. The incision is continued upward from the clavicle over the supra-

clavicular triangle to the border of the middle of the sterno-cleido-mastoid muscle. The internal jugular vein is exposed at the inner side of the triangle, and all the fat and lymphatics removed from within outward, down to the clavicle and outward to the outer border of the triangle.

The edges of the incision are brought together by a purse-string silk suture, including only the base, however, of the triangular flap. This flap is attached so as to furnish a lining for the axilla. Drainage is ordinarily unnecessary. Healing is usually by first intention. The central portion of the wound, which cannot be brought together, often heals under the blood-clot; and if regular granulation forms, this surface can be quickly covered by skin-grafts after the method of Thiersch. The impairment of movement in the arm is very much less than would be imagined from so extensive removal of muscle.

Many operators do not consider it necessary to make so extensive a dissection in removing the breast, and think the removal of the supraclavicular node is only necessary in exceptional cases. Dr. Halsted states that in 7 favorable cases, where the tumor was recent and small and the nodes only slightly enlarged, after the removal of considerably less tissue than in the above-described operation, he had 3 local recurrences, whereas in a series of 50 complete operations, many of them much less favorable from the extent of local infection, there were also but 3 local recurrences. This statement alone is sufficient encouragement to the operator to master the technique of the operation by practice upon the cadaver, and to carry it out completely in every case of malignant disease of the breast.

PROGNOSIS.—It must be admitted that the prognoses of operations done in the past for cancer of the breast have been most unfavorable, according to statistics, but a few months at most being added to the patient's life by the operation. This fact has become so well understood by the laity that women suffering with cancer of the breast have preferred to let the disease take its course, rather than submit to a serious mutilating operation, which offered at best but a temporary respite. Thanks to the labors of such men as Volkmann and the more recent work of surgeons in our own country, there is a definite hope of freedom from local recurrence in at least 50 per cent. of the cases operated. Certainly a larger number than this ultimately succumb to the metastases in internal organs, but for these the surgeon cannot be held responsible.

In order that these favorable results may be secured the operation must be done early, if possible before the skin has become involved or the lymphatics extensively implicated, and the operation carried out thoroughly as described.

Many different drugs have been suggested in the treatment of sarcoma and carcinoma, but not a single one has stood the test of time. The local application of the various caustic pastes and solutions so frequently used by irregular practitioners is not to be recommended. The pain inflicted is much greater than that caused by the cutting operation, while the destructive activities of the caustic cannot be entirely controlled. Furthermore, it does not reach the infected nodes, and is therefore always an incomplete operation.

More recently, Dr. Coley of New York has suggested a method of treating malignant tumors by injecting them with toxines. Coley first used a filtered toxine of the streptococcus erysipelatis, to which in later experiments he added the toxine of the bacillis prodigiosus. At the present time he uses a mixed unfiltered toxine of the streptococcus erysipelatis and bacillus prodigiosus. Toxines prepared after one or other of these forms have been tested now for three years by its enthusiastic promoter, as well as many other experimenters, notably Czerny of Germany. This treatment should only be applied in an inoperable tumor, where

from the extent of the disease or its location or the condition of the patient a complete operation for its removal cannot be performed. The effect of this treatment seems to be decidedly more favorable in sarcoma than in carcinoma. Coley reports 9 cases of probable cure at periods from six months to three and a half years after treatment, out of 38 cases of inoperable sarcoma. No report of a cure of a case of carcinoma by this method has yet been made, though a stay of growth, and even a temporary diminution in the size of the tumor, have been reported. The use of *cancer serum*, together with the toxine of the streptococcus erysipelatis, as suggested by Emmerich and Zimmerman, is still too recent to make any statement of its possible value. As it seems pretty well established that the mixed toxines have the distinct effect of diminishing the volume of sarcomata, would it not be excellent treatment to use them after surgical removal of sarcoma in order to destroy any foci of cells which may have been left behind, and thus diminish the danger of a recurrence? Thus far, it must be confessed, the results obtained are very unsatisfactory, and the method itself must be held *sub judice*. But even if these methods should prove quite inadequate, may we not hope that along these lines of experimentation some method of treatment may be found by which such fearful mutilations as amputation of the breast may no longer be necessary, and humanity spared the anguish and suffering of malignant disease? (*Vide* also Appendix to Chapter XXVI. Vol. I.)

CHAPTER XV.

AMPUTATIONS.

By Rudolph Matas, M. D.

An operation by which a limb or part of the body is removed by the knife or other means is an amputation. In this chapter only the amputations of the extremities will be considered.

CLASSIFICATION.—Into *typical*, when an amputation is performed according to established rules or methods; *atypical*, when the procedure adopted is irregular and without regard to fixed precedent, with the view of meeting anomalous or accidental conditions. When a limb is removed at a joint it is an *amputation in contiguity* or *disarticulation;* when the section of the limb is made elsewhere than at a joint it is an *amputation in continuity*. Amputations have been classified according to the time or period when the operation is performed, thus : (1) *Immediate*, before reaction from shock, usually within the first twelve hours ; (2) *primary*, after reaction, but before inflammation ; (3) *intermediate*, after inflammation, but before suppuration ; (4) *secondary*, after suppuration has been fully established. For all practical purposes these four periods can be reduced to the *primary* and *secondary*—i. e. (*a*) after reaction, before infection ; and (*b*) after infection.

General Indications.

In general terms an amputation is indicated when a part of a limb can be saved, or when life can be preserved or prolonged or made bearable, by no other means. The conditions that call for amputation have been enormously restricted since the advent of antisepsis. The most frequent and urgent indications for amputation are furnished by—(1) the violent traumatisms which result from railroad, machinery, and other accidents, which cause extensive and irreparable damage to the soft parts and bones ; (2) when the physical condition of the patient is such that a long post-operative treatment and long confinement in bed consequent upon conservatism, even if immediately successful, would leave a useless limb ; (3) amputations are called for in certain pathological conditions (non-traumatic) which render an extremity totally incapable of performing its functions, or which permanently interfere with the patient's comfort and usefulness, or which threaten his life. In this category may be classed the chronic diseases of bones and joints (tubercular osteoarthritis, osteomyelitis, tenosynovitis, etc.) which have resisted conservative treatment ; the benign and malignant neoplasms that cannot be removed without the sacrifice of essential parts ; large circumferential ulcers which resist grafting or other treat-

ment, very rare at present; perforating trophic ulcers of the foot; spreading sepsis; intermuscular suppuration with threatening general infection; malignant œdema; spreading atheromatous or embolic gangrene; diabetic gangrene; aneurisms that burst in joints; and congenital or acquired deformities that interfere with the comfort of the patient.

Local Indications furnished by the Injured Parts.—The avulsion or tearing away of a limb admits of no doubt. No doubt will exist when a limb at or below certain points is crushed so that the circulation in the distal part is impossible. *Compound fractures* of both the bones when badly comminuted formerly called for amputation; now they rarely do, unless too great length of bone is implicated and unless the soft tissues have suffered severe laceration. It is a good rule, other things being favorable, to attempt to save a limb if not more than two inches of the principal bone is comminuted. In attempting to estimate whether or not soft tissues have undergone too great injury for any conservative attempt, the muscular laceration should receive less consideration than the degree of injury to the skin. It is rare to save compound comminuted fractured limbs having slight laceration of the muscles, but extensive injury to the skin. One or two lacerations of the skin are not particularly hurtful; it is the complete death of the skin through immense pressure, as of a weight, produced by crushing of a car-wheel or a heavy beam or a stone. If all the muscles at a given point are pulpefied, amputation is of course indicated. *The Vessels.*—There is great danger from rupture of the main artery of a limb, a difficulty greatly increased by subcutaneous bleeding, compressing all the tissues through which the collateral supply might be established, as by a simultaneous injury of the main vein. Serious injury to the femoral or brachial vessels, high up, by a compound fracture, usually requires amputation, but a system of vessels in the forearm or leg (the anterior tibial and its branches, for instance) may be entirely destroyed at a given level and yet the limb be saved.

Great contusion and laceration of muscles without fracture of bone and little injury of the skin rarely necessitate amputation—certainly not primary amputation. The important point is to relieve the immense tension of the skin on account of subcutaneous extravasations of blood-serum by immediate multiple incisions or punctures of the skin (after previous sterilization), to drain away the effused fluid. No drainage-tube should be used, not even a strip of gauze; only cauterization is required, as the least local pressure will usually cause necrosis of the already badly nourished skin, from which infection is apt to occur (Estes).

Injury to the skin without serious injury to the deeper parts, with the exception perhaps of the entire sole of the foot, should rarely call for amputation, owing to the great progress accomplished in grafting. In doubtful cases, when the viability of the parts cannot be determined by existing conditions, the surgeon must not be precipitate in his action, since there is very little danger in delaying the amputation as long as asepsis is maintained.

The essential point to remember is, that in doubtful cases the delay pending a decision is permissible, but is only made safe by the maintenance of the most rigid asepsis. So great is the confidence of some surgeons in the power of asepsis to ward off the formidable dangers of the microbial contamination of the injured tissues that they would advise the complete abandonment of immediate amputations in the primary period in all cases. Réclus of Paris has certainly demonstrated by his recent brilliant results that it is perfectly feasible to maintain perfect asepsis even in the most extensive areas of dead tissues, and thus ward off the dangers of putrefaction until the natural processes have succeeded in separating the living from the dead parts. The advantage claimed for this procedure is to entirely eliminate the danger of shock, and to preserve more of the living and useful tissues than would be possible by a primary amputation performed in sound tissues.

Réclus and his followers recognize the fact that crushed tissues are always infected by germs from the skin, the clothing, or earth, and form a peculiarly favorable soil for the growth of such germs. Not only is the crushed limb perfectly useless, but if left in place it endangers life from profuse suppuration, from traumatic gangrene, and from tetanus, though the last can be warded off by a prophylactic injection of its antitoxin. An amputation wisely arranged does away with all these dangers. This reasoning, he holds, was absolutely incontrovertible before antisepsis attained its present perfection by the thorough methods that he practises: there is no fear of such complications, provided the patient is seen early enough after the accident for antisepsis to be effective. After infection and putrefaction have set in, it is obvious that the opportunity for antisepsis is over, and the only hope of recovery lies in immediate amputation.

The advice given by Réclus is certainly suggestive of the possibilities of asepsis, and emphasizes the lesson that unless the injured tissues are plainly infected *already*, the surgeon need not hurry to operate when he is in doubt as to their viability. There are certain conditions, like frost-bites, scalds, crushed wounds of the hands and feet, which should always be treated with the utmost conservatism, nature being allowed to draw the line between the living and the dead tissues in order to save every viable particle.

In such cases, and in all cases in which profound shock precludes the possibility of immediate operation, or when it is not clear that the injured parts have been permanently devitalized, the injured area should be subjected to the most scrupulous antiseptic preparations. When the patient has rallied from shock and the death of the parts is unquestionable, there can be no advantage in waiting for nature to accomplish with very laborious and exhausting efforts what the surgeon can do in a few minutes with the knife, even if one or two inches more of tissue must be sacrificed in cutting through healthy tissue. In fact, the most recent and conclusive experience (Estes) teaches that the sooner an amputation is performed after the indications for the amputation are clearly formulated the better will be the ultimate result.

In every case the condition of the patient, his ability to stand the additional shock of an amputation or to cope with the danger of existing or prospective infection, exhausting fever, and suppuration, must decide the operator in his preference for an immediate amputation.

INSTRUMENTS.

The instruments required to perform an amputation may be classified into those for (1) the prophylactic and direct control of hemorrhage; (2) for cutting, dissecting, retracting, elevating the soft parts; (3) for sawing the bone; (4) for suturing the flaps.

In addition, material will be needed to—(1) ligate the bleeding vessels; (2) suture the flaps and approximate the soft parts; (3) to sponge; (4) to drain; and (5) to dress the wound and stump.

The prevention of hemorrhage is essential in order to avoid the dangers of acute anæmia and shock. To secure an absolutely bloodless condition of the part to be amputated several methods of controlling the circulation have been devised. Of these, compression of the main artery with the fingers (digital compression) of an assistant may be applied in favorable spots. Thus the subclavian may be controlled in the supraclavicular fossa by the finger applied over the skin or through an incision or by a mechanical contrivance—viz. a padded key; the brachial by the finger over the line of the artery. The arterial supply of the lower limbs may be controlled by compressing the abdominal aorta on a level with the umbilicus by the pressure of the closed fist (Macewen's method), or by mechanical compression, or by directly compressing the

iliac with the finger through an aseptic peritoneal incision (McBurney and others). The entire circulation of a limb is most effectually controlled by encircling the root of a limb by a constricting apparatus, of which the simplest in an emergency is a rope or cord thrown around a limb and made tight by twisting it with a stick (Spanish windlass), or, more securely still by the use of any of the numerous tourniquets of which many models have been in use for centuries, of which J. L. Pettit's is probably the most familiar example. All these methods of securing the complete local anæmia of a limb (ischæmia) have yielded in modern practice to some modification of the following method:

Esmarch's Method.—This consists in the application of an aseptic elastic rubber bandage over the limb after this has been suitably sterilized and covered with a soft towel, wet with a bichloride (1 : 1000) or carbolated (2½ per cent.) solution, which is wrapped around the affected limb. The elastic bandage is applied tightly from below upward in an even spiral (without reverses), and is carried as high up as is desired. The blood is all driven out of the vessels as the bandage is adjusted. Immediately above the upper terminus of this elastic roller a rubber band or hollow elastic tube is wound several times around the limb with sufficient contracting force to entirely arrest all arterial pulsation below it. The constrictor is then held in place by tying it or by a clamp (Wilson's sigmoid clasp is the simplest of the numerous devices that have been introduced for the purpose). After the constricting band is secured the elastic roller is removed, and the limb below the constriction assumes a characteristic pallor which markedly contrasts with the healthy redness of the parts above. The operation can then be performed precisely as upon a cadaver, and is absolutely bloodless.[1]

In applying the elastic constrictor or tourniquet at the root of the limb the following precautions should be observed : (1) Never apply the constrictor over the leg or forearm, as the interosseous vessels are protected from pressure by the two bones of these regions, and hæmostasis must be imperfect. Always apply the elastic tourniquet over the femoral or humeral shafts, or at such points (the roots of the digits) where no vessel can escape circumferential compression ; thus in the lower third of the femur, just above the condyle, the rigid adductor magnus tendon may interfere with complete compression of the femoral. (2) In applying the elastic tourniquet begin by compressing the vascular or adductor side so that venous choking of the limb may be obviated. This precaution is especially important when Lister's method is followed. (3) While encircling the limb with the elastic band it is necessary to avoid the repeated constriction of the same circle (linear constriction), as an exaggerated concentric compression may, in thin subjects especially, permanently paralyze the extremity by crushing the underlying nerve-trunks. Therefore separate each turn of the rubber by an intervening space. (4) Do not allow the constricted member to be decidedly fixed or extended after the constrictor is in place, for fear of tearing subcutaneously the underlying muscles and nerves. (5) Do not keep the constrictor much longer than an hour in place, because sloughing from prolonged arterial fasting and coagulation-necrosis of the distal edge of the flaps is likely to result. This is especially true of cocaine operations, in which the constrictor is likely to be retained longer for anæsthetic purposes. It greatly favors the absorption of toxic chemical antiseptics, as shown by Wölfler's experiments.[2]

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[1] Esmarch has maintained his artificial anæmia in human limbs for two hours and a quarter without consequent necrosis. Such a length of time is positively dangerous, especially when dealing with inflamed and contused tissues, and should be avoided.

[2] After great losses of blood, which endanger life, Esmarch's bandage may be applied to the extremities in order to force the blood in the latter toward the heart, and so avert threatened heart failure or cerebral anæmia (auto-transfusion).

Objections to Esmarch's Method.—(1) Excessive capillary oozing, requiring an undue manipulation, an irritation of the injured tissues, and the ligature of many more bleeding points than usual. This is due to vasomotor paresis of the compressed area, and can be corrected by the stimulus of hot water applied to the cut surface and by stroking or superficial massage of the limb. (2) It increases the risk of septic embolism and of cancerous metastasis by forcing particles from the diseased area into the venous and lymphatic circulation. (3) It greatly favors the absorption of toxic chemical antiseptics, as shown by Wölfler's experiments.

These objections have led to an *application of the rubber tourniquet alone* (Esmarch's principle), which secures satisfactory ischæmia *without the preliminary elastic compression of the limb.* Instead of applying the elastic bandage, the limb is held up in such a manner that the blood is drained out by gravity. While the limb is being held up it is stroked vigorously from the tip of the extremity (fingers or toes) to the trunk ; the process (milking the limb) is followed by the application of the elastic constrictor at the root of the extremity. This method, which is at present known as *Lister's method*, is very efficient, and, owing to its freedom from the objections urged against elastic compression, bids fair to supplant the typical Esmarch method in most cases.

Instruments for Cutting, Dissecting, and Retracting the Soft Parts.—One or two ordinary large scalpels are all-sufficient for the performance of modern amputations. The formidable rapier-like knives of earlier days have been discarded since the abandonment of the transfixion methods so popular in the pre-anæsthetic period, when security was so frequently sacrificed to rapidity. Nevertheless, a strong, medium-sized amputating knife (6–9 inches of cutting edge—Liston's model) is almost a necessity in dividing the thick muscular layers and skin in a circular amputation of a stout subject ; a long, narrow, and straight knife to divide the interosseous membrane and to disarticulate the smaller joints is required to operate with rapidity and elegance. A plain or rat-tooth dissecting-forceps, a stout pair of straight scissors, and a periosteotome to clear the bone of periosteum at the point of division, complete the outfit required for the division and retraction of the soft parts. Cloth retractors, made with stout aseptic gauze, will be required to protect the soft parts while the bones are sawn.

When one bone is to be divided a small towel with a tear in the centre will answer the purpose. When two bones are to be divided, as in the forearm or leg, a broad strip with three tails (one for the interosseous space and two for the sides) is used ; and when the fingers or toes or their metacarpals are to be removed simultaneously, a six-tailed retractor must be used. The metallic retractors recently recommended by McCurdy may also be used with advantage.

For the direct control of the bleeding points a tenaculum is often needed to drag out retracted vessels ; but the ordinary hæmostatic clamp will suffice to secure divided arteries until they are permanently secured with ligatures or obliterated by torsion. As many artery-clamps will usually be required as there are bleeding points.

To Divide the Bone.—The bones are usually divided with a saw. A bow saw (Butcher's model) with adjustable blades, a capital saw with movable back, a metacarpal saw, will usually suffice for all purposes ; Lister's cutting pliers, straight and bent, for division of phalanges and metacarpals ; and gouge or rongeur forceps to nip off irregular projecting ends. A lion-jawed forceps (Farabeuf's) or osteophor may be needed to steady the movable end of the bone in re-amputating a stump.

A Gowan-Wyeth's exsector and Macewen's chisels will also be useful in amputating by Neudörfer's methods, and even a chain-saw may be used with advantage in all cases in which it is especially important to avoid injuring the soft parts with the saw.

Bleeding from the bone-marrow is usually best controlled by suturing the periosteal flap over it. Halsted's catgut wool and Horsley's antiseptic wax have been used to control excessive oozing, but simple compression and the temporary use of hot water, followed by periosteal suturing, are usually sufficient for the purpose.

For suturing deep muscular layers and skin-flap the Keith or Hagedorn needles are undoubtedly the best, and the McBurney-Abbe needle-holder will be found to be the most convenient and generally useful. In supporting heavy muscular flaps silver sutures may be required, and for this purpose ordinary needles threaded with silk may be used as carriers. The material for suturing has been sufficiently described in other sections of this work, and need not be discussed here. Suffice it to say that fine sterile silk is still used with the greatest confidence by the profession, and is certainly infinitely more reliable than catgut if there be reason to apprehend suppuration. Catgut or kangaroo tendon answers well for the approximation of the deep muscles and obliteration of dead spaces. Silkworm cannot be excelled, and is the ideal material for approximating skin flaps.

Sponges.—The sponge has been discarded in amputations, as in other operations, in favor of gauze mops made of sterile gauze cut into long strips, with which the surface is thoroughly dried according to the now generally accepted " dry method of Landerer." In amputations through septic surfaces copious antiseptic irrigation is required, and here, again, the cloth mop or a towel (6 by 12 inches) will serve instead of the sponge, as it is thrown away and destroyed, and thus never exposes the patient to infection, as is likely to occur with the sponge.

Drainage.—In all amputations through infected areas thorough drainage must be provided for. This is best secured by packing the stump with iodoform gauze, which is removed in a few days, when the surfaces may be allowed to come together if healthy. In cutting through sterile tissues no drainage is required if there is absolute certainty that asepsis has been vigorously maintained and no irritant antiseptic irrigation has been produced. If such is the case and the *dry* sterile method of Landerer has been adopted, the deep surfaces can be approximated and all dead spaces obliterated by catgut or buried sutures. Finally, the skin-flap surfaces must be closed by interrupted silkworm sutures.

If there be any doubt as to the asepsis, it is also much safer, even in healthy-looking wounds, to use either a short soft-rubber or a glass drainage-tube at each end of the stump to facilitate drainage.

In sutures the greatest care must be exercised not to suture too closely or too tightly, for fear of strangulating the edges of the skin-flaps, especially in the lower extremities, where this risk is proportional, in equality of circumstances, to the distance of the cut edge from the heart.

Dressings.—If the stump be septic and a tampon of iodoform gauze be used, adjust another layer of the same gauze over the surface of the

stump. Then cover the whole surface with sterile gauze; then over this, again, a large pad of sterilized absorbent cotton sufficient to protect the stump from all possible mechanical injury. Finally, a bandage must be snugly applied. If the toe has been removed, cover the foot up with dressings to the ankle; if the foot itself has been removed, cover the whole leg and put on a splint under the knee and thigh to secure rest. If the leg be amputated, cover it up to the middle of the thigh, and also adjust a comfortable postero-lateral splint like a trough made of perforated tin or binder's board, which can be easily moulded to the surface. The same principles apply to the upper extremity.

Créde's Method.—Créde discards drainage and sutures and brings the flaps together by means of equable pressure with gauze bandages. In his cases the result was satisfactory, the stumps being in excellent condition at the end of ten days. This method can only be utilized in septic conditions or in other states in which the vitality of the flaps would be endangered by suturing.

METHODS OF AMPUTATION.

From Hippocrates to the time of Celsus the surgeon simply followed in the wake of nature, never venturing to apply the knife for the removal of a limb except within the limits of the mortified tissues; and this seems to have prevailed for at least four hundred years. Celsus, the prince of Greek physicians, who lived shortly after the time of Christ, introduced the first innovation by cutting down to the bone between the living and the dead tissues. It is probable, according to the evidence furnished by his writings, that he was aware of the value of the ligature and that he applied it to control bleeding vessels. Archigenes, following closely after Celsus, was the first to attempt prophylactic hæmostasis by applying a cord or band around the limb to control the hemorrhage during the amputation. With the fall of the Roman Empire and the advent of the long night of the Middle Ages the Celsian method was lost in the general darkness and the old Hippocratic doctrines survived, and were maintained by the all-potent influence of Galen and his Arabian commentators. As late as the middle of the seventeenth century the only hæmostatic was the actual cautery and boiling oil, though Guy de Chauliac had revived the teaching of Archigenes by constricting the limb, on a level with a joint, with a cord which was allowed to remain *in situ*, to ensure not only hæmostasis, but a certain mortification of the stump. In cutting limbs huge chisels and mallets were used. At this period Botalli invented his guillotine, consisting of a sharp heavy axe, which, being allowed to fall from a height upon the limb, severed it instantaneously at a single blow. The revived or independent rediscovery of the ligature by Ambrose Paré in 1579, and the discovery of the circulation of the blood by Harvey in 1628, led to the invention of Morel's tourniquet (1674), more commonly known as the Spanish windlass, and to the familiar instrument, Pettit's tourniquet, which (introduced in 1718) perfected the means of securing prophylactic and direct hæmostasis. From this time onward the treatment of the stump began to receive more systematic attention. Instead of merely chopping off a limb, the soft parts were detached from the bone, so that this could be sawn off at a higher level, in order to avoid the conical projection of the stump which invariably resulted when the primitive methods were adopted. All the methods of amputation that followed—and these were numerous—aimed chiefly at celerity, to reduce the pain of the operation to a minimum, hence the rapid circular section of the soft parts or the rapid transfixion methods which were so much popularized by the brilliant work of Liston, Lisfranc, Desault, Dupuytren, Langenbeck, and others. These finally yielded, in this modern period, to less rapid but more conservative and perfected methods, which aim chiefly at the preservation of useful tissue and at securing the very best functional prosthetic stump for the patient. Such methods could only be perfected after the advent of anæsthesia and antisepsis.

CLASSIFICATION.—All methods of amputation may be classified, according to the mode of division of the soft parts, into (1) the *circular* and its derivatives—the *oblique, elliptical, oval, racket,* and *double-quadrangular flap methods ;* (2) the *flap method ;* and (3) the *mixed, superficial flap of skin* and *deep circular of the muscles.*

The main point to be considered in the selection of a method is the following : the least sacrifice of the healthy tissue of the limb compatible with the saving of life and with the greatest possible use of the stump to the patient.

To secure this most important desideratum the following conditions must be complied with : (1) The bone must be amply covered ; (2) the skin must not be adherent to the bone nor exert pressure or traction upon the cicatrix ; (3) the soft parts, especially the skin, must be subjected to the least traumatism compatible with the proper performance of the operation, with a view to disturbing the blood-supply and nutrition of the flap as little as possible ; (4) the main vessels must be cut transversely ; (5) the nerves must be cut high enough, so that they may not become adherent to the bone or cicatrix, or be affected by pressure upon atmospheric changes ; (6) projecting angles or irregularities of the bone must be smoothed and rounded, so that they may not unduly press upon the soft parts ; (7) the section of the soft parts must be made with the view of reducing the exposed scar-tissue to a minimum, and securing for this a position in the stump that shall be away from friction and the chief pressure-points in adjusting an artificial limb or other prosthetic appliance.

In connection with the last conditions perhaps it may be well to remember a few general facts of practical interest : The *contractility of the skin* is subject to great variations : it is practically lost in parts that have been long inflamed and œdematous. The average contractility of the skin may be represented by one-third of the length of any given portion. Thus a flap 12 cm. long will be reduced after section to 8 cm. The amount of retraction of muscles is proportioned to the length of the fibre ; hence long-fibred muscles, like the sartorius, gracilis, the hamstrings, contract enormously. The contractility of all the soft parts together may be stated as follows : The primary and immediate retraction of the tissues forming a flap may be represented as one-third of the length of the flap—that is, if a flap of 10 cm. is required to cover the bone, it should be cut 15 cm. (Farabeuf). In cutting the flaps we should therefore make allowance for this retraction, which is to be added to half the diameter of the limb in measuring the length of the flap. While half a diameter is usually given by most authorities as sufficient length of flap-covering, we believe that experience justifies the establishment of the general rule that the length of flap-covering for a stump, after making due allowance for primary or secondary retraction of the soft parts, should correspond to a *full transverse diameter* of the limb. In very wasted, relaxed subjects, with loose, pendulous skin, one-half a diameter will be amply sufficient.

To meet the conditions of the present day some of the simplest and oldest methods, modified by the improvements of modern technique, have again been utilized, and are coming more constantly into surgical favor. These are the circular incisions. With Kocher, Wyeth, and others we believe that circular amputations fulfil the general indications better than any other fundamental type of operation. In circular amputations we include not only transverse incisions, but also those running obliquely to the axis of the limb, provided the line of the incision continues in one direction or the incision lies in a single plane. The addition of a single longitudinal incision with rounding of the angles results in the so-

PLATE XIII.
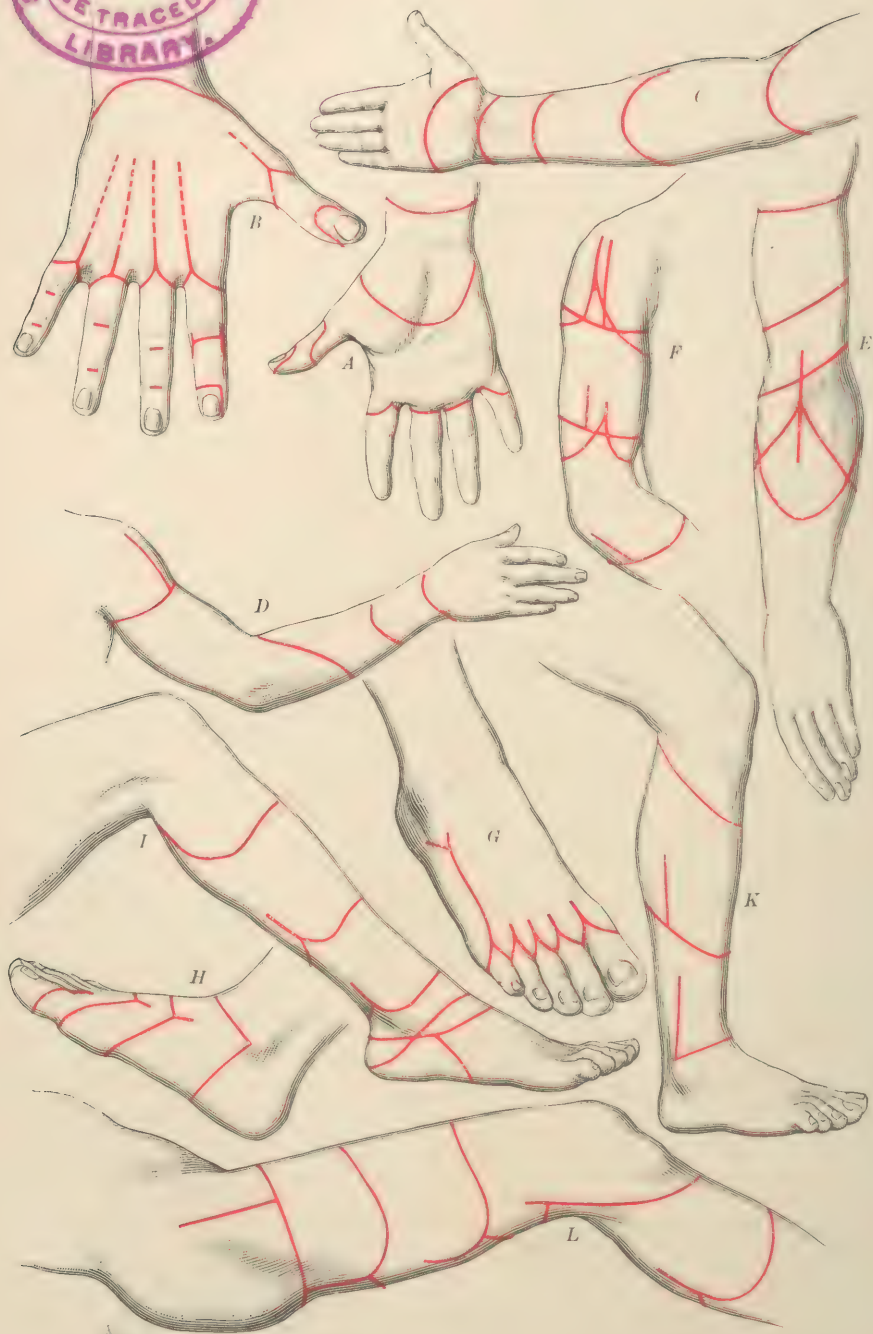
Illustrating Lines of Skin Incision in Amputating at Various Levels.

called oval incision (an oval with a pointed side is not strictly an oval). The addition of two longitudinal incisions with rounding of the angles results in a true flap operation.

The *racket* (Malgaigne's *en raquette*) and the *quadrangular flaps* of Ravaton and Teale are transitions from the circular to the latter method. The tendency is, therefore, to prefer the circular, modified to suit certain localities. We shall adopt it as a fundamental method of election, and shall refer to other procedures incidentally to the special amputations where they are indicated. (*Vide* Plate XIII.)

The *transverse circular method* is not only the simplest and the most easily executed, but it secures to the skin the best vascular supply and nutrition. It is contraindicated in favor of the oblique-circular or elliptical method, which is virtually also a single-flap method—(1) when more healthy skin is present on one side of the limb than on the other, otherwise the amputation would necessarily have to be carried higher; (2) when the cicatrix cannot be placed at the end of the stump, because it is exposed to pressure from below; (3) when, owing to the excessive elastic retraction of certain regions (as in the adductor and flexor regions of the thigh and the flexor region of the elbow), a transverse circular would leave an insufficient flap (Kocher).

There are two modes of performing the *circular amputation* at the present day : (1) *The simple (solid musculo-tegumentary) method, without cutaneous cuffs.*

STEPS.—(1) *Division of the Skin.*—Both hands of the assistant retract the skin vigorously toward the root of the limb. With a medium-sized amputating knife the skin, subcutaneous adipose tissue, and superficial fascia are cut circularly with the same stroke. (2) At the margin of the fully retracted skin the muscles are divided in successive sections in a plane transverse to the axis of the limb. When the muscles are thick the superficial muscles are first severed and allowed to retract upward, and the deeper layers are divided in a higher plane because the superficial muscles usually retract more vigorously. When the periosteum is reached it is incised circularly in the plane in which the deep muscles have retracted. The periosteum is pushed with an elevator along the bone as far as necessary to cover the sawed surface. The bone is severed at the margin of the detached periosteum. When the periosteum adheres closely, as on the rough lines of the epiphyses and tendinous attachments, it is separated with the knife.

In all cases in which the end of the bone is to act as a direct support, and in the lower extremity where the soft parts are likely to rest against sharp projecting angles, these must be rounded off by the saw.

This type of circular amputation can be advantageously modified by cutting a short cuff of skin (one-fourth or one-fifth of the full length), after which the muscles are divided squarely to the bone and then elevated with the periosteum as before.

(2) *The Skin-cuff Circular (à la Manchette).*—In this method the flap is made wholly of skin, which is dissected up to the line of bone section, where the muscles are divided perpendicularly to the bone. In making the dissection care must be taken to include the subcutaneous fat and superficial fascia *in solido* with the skin. The edge of the knife must never be directed toward the skin, but always against the underlying tissue.

In order to facilitate the retraction of the soft parts, especially in well-developed muscular subjects, in cutting through conical regions, as in the upper third of the forearm, lower and middle third of the thigh, middle of the leg, and in disarticulating the shoulder and the hip, a *liberating vertical incision*, made in the least vascular and less exposed aspect of the limb, usually the outer surface, will aid very materially in facilitating the operation. In some regions two incisions may be required at equidistant points, which are cut straight to the bone parallel with the axis of the limb and at right angles to the circular incision, thus transforming the circular into two even equilateral musculo-cutaneous and

well-nourished flaps, which are peeled solidly from the bone with or without the periosteum, as was suggested by Ravaton in the eighteenth century.

A further modification of the solid circular which reduces the disturbance of the soft parts to a minimum is the method suggested recently by Neudörfer of Vienna (1891). In this procedure an incision is made on the outer or least vascular part of the limb parallel to the long axis of the bone. The knife is carried down to the point of the proposed osseous section. The bone is then divided with the chisel or a Gowan's exsector, or, better, with a chain saw, and the soft parts are simply lifted up subperiosteally a sufficient length below the saw-line to ensure an ample covering. In certain conditions, such as amputations of the thigh for diabetic and senile gangrene, in which it is extremely necessary to protect the vascular supply from injury, this method is certain to remove the limb with the least exposure of the blood-vessels.

The *Elliptical method* has already been referred to as an oblique circular, and occupies an intermediate position between the circular and single flap. In this amputation the upper and lower ends of the ellipse are best marked by a small incision made by pinching up a fold of the skin and cutting over it. The skin and subcutaneous tissues are retracted by gliding or turning a cuff up to where the highest point of the ellipse is reached; the muscles are cut squarely to the bone as in the circular incision. Guyon's supramalleolar amputation of the leg, the elliptical disarticulation at the elbow, are examples of this modification of the circular.

The Oval or Racket Method.—The incision takes the form of an oval with an end pointed (pedunculated oval) or of an isosceles triangle rounded at its base. The edges of the wound are united in its long axis. The most typical application of this method is seen in amputating the fingers. (See Fig. 259.)

The Flap Method.—The flap may be either cutaneous or musculo-cutaneous. In every flap the skin must be cut larger than the muscles. Unless the flap is subperiosteally dissected, a pure muscle-flap is unwieldy and difficult to adjust. A pure skin-flap is very apt to slough. This tendency, as Farabeuf has shown, is least observed in the integument about joints, where the vascular supply of the skin is derived from many channels. Flaps may be single or double. Carden's original transcondyloid of the femur is a typical example of a single-flap method. The limb may be amputated by a long external flap method, but the oblique circular recommended in other places is almost identical in its technique and results.

Double flaps may be antero-posterior or lateral. They may be equal in size or unequal. In order to meet the cylindrical form of the limb, the flaps will fit better if made of a U shape than if cut square. This can be done in a circular amputation with lateral incisions which have two even square flaps by rounding the corners (Ravaton, Langenbeck).

The flaps may be cut in three ways:

(1) By *transfixion*. This was the favorite method in the pre-anæsthetic period, and in the hands of such masters as Liston, Lisfranc, Fergusson, and others was marvellously rapid in its execution.

The great objection to this method lies in the oblique and irregular division of the main vessels, which imperils the nutrition of the flaps, and also in the lack of control of the knife in making the section of the soft parts. The method cannot be recommended, and is rapidly becoming only historical. It is still applicable in cutting through tendinous regions, as in the wrist, after the circular section of the skin cuff from without inward.

(2) By *cutting a flap from without inward.* The outline of the flaps is made by incising the skin with a scalpel. After the skin and fascia have retracted the muscles are cut obliquely to the bone, so as to leave a thinner section at the margin than at the base. Antero-posterior flaps of the thigh and of the arm may be cut artistically in this way by a skilled operator. Each flap should be at least half a diameter, and preferably three-fourths of the longest diameter of the limb.

(3) *Flap formed by enucleation or desossement.*

Subperiosteal excision is exhibited in its purest type in Teale's double, *unequal*, quadrangular flap amputation, or in Stephen Smith's hooded flap of the leg; also in lifting up from the radius and ulna the double square flaps resulting from a solid circular with two lateral incisions on the Ravaton plan.[1]

SPECIAL AMPUTATIONS.

A. AMPUTATIONS OF THE UPPER EXTREMITY.

Amputations of the Fingers.—*Rules:* (1) Save all parts of a finger, as no prosthetic appliance can replace the tactile or prehensile function of the lost digit. Exception: The proximal phalanges of the middle and fourth fingers, which usually remain stiff, extended, and in the way when the other fingers are present; save them, however, when all the other fingers are lost.

(2) The palmar surface is the most exposed to friction; it is the most sensitive and useful; save and use it as flap material in preference to the dorsal integument, so that the scar in the stump may be placed on the back of the hand, in the least sensitive and most protected locality.

(3) The prominence of the knuckles is caused by the proximal bone (nearest the trunk), and the joint is below the knuckle. The line of articulation of the ungual and middle phalanx is one line, or one-twelfth of an inch, below the knuckle of the flexed finger; the joint of the middle and proximal phalanx is two lines, or one-sixth of an inch, below the knuckle; and the metacarpo-phalangeal joint is four lines, or one-third of an inch, below first knuckle (LeFort). This is important in disarticulating.

(4) The joints are best exposed by flexing the finger.

(5) The arteries and *nerves* exposed are situated on each side (lateral surface) of each finger—important for hæmostasis and cocainization.

(6) The synovial sacs which envelop the tendons of the thumb and little finger are prolongations of the common palmar bursa, which extends below the annular ligament into the forearm. The bursæ of the other digits are independent of the palmar bursa. Hence the greater risk of palmar infection in amputations and injuries of the thumb and little finger. The tendon-canals of all the fingers directly lead to the palm: this is also an easy route for infection to the palm.

Methods.—The method of election should be—(1) For *disarticulation of phalanges:* Lisfranc's long palmar flap, made by running a long bistoury (finger-knife) into the joint and carrying it out between the distal phalanx and soft parts, until sufficient material is obtained to snugly cover the exposed proximal knuckle. This operation leaves a well-padded stump, without the scar in the dorsal surface.

[1] *Teale's Amputation.*—*Rule:* Measure the circumference of limb on a level with future saw-line, cut a long flap, preferably on the exterior surface of the limb, measuring half a circumference in length and in breadth. Then a short (usually posterior) flap one-fourth the length of the long flap and one-half of the circumference of the limb in breadth. It is most applicable in the lower leg.

(2) *For amputation through a phalanx:* (1) A short, dorsal square flap dissected directly from the bone; (2) a flap two-thirds longer taken from the palmar side is also lifted up from the bone, which is sawn or cut through with pliers. The flap is then turned over on the dorsum to be sutured to the short flap. This leaves an admirably well-padded stump.

Amputation of the Entire Finger (inter-phalangeo-metacarpal disarticulation).—The free edge of the web of the fingers, as measured from the palmar surface, is about three-fourths of an inch from the metacarpo-phalangeal joint. The operations of election for these fingers are —(1) for the index, a modified oval or racket flap, with longer flap prolongation on the radial side, so that the scar will rest as far as possible from the exposed edge of the palm. A longer palmar flap will also accomplish the same purpose. (2) For little finger (auricularis), the intero-external flap : the greatest length of the flap is on the ulnar side of the digit, so that the scar will be placed away from the ulnar or exposed aspect of the palm. (3) The middle finger is best removed like its fellow, the fourth finger, by either a simple circular cut corresponding to the line of the palmar web and a dorsal slit (Ravaton's method), which allows a free exposure of the joint, or by a Malgaigne racket. (4) The thumb can be disarticulated with greatest advantage by either a single palmar flap or a Malgaigne's racket. By whichever method, the sesamoids attached to the short flexor of the thumb should be resected.

Fig. 259.

Illustrating various finger amputations (Farabeuf).

Amputation of Two or More Adjoining Fingers Simultaneously.—The best plan is to forego brilliancy and to adopt the incisions in each case which will ensure conservatism and scar protection.

AMPUTATION OF FINGERS WITH THE CORRESPONDING METACARPALS.

GENERAL PRINCIPLES.—(1) The amputation of a finger and a part of its metacarpal is a simple, benign, and conservative operation.

(2) The amputation of a finger with a *total* extirpation of its metacarpal bone is a difficult, serious procedure which is rarely called for.

(3) The only exceptions or partial exceptions are the first (thumb) and fifth metacarpal bones, the extirpation of which is comparatively easy and safe, owing to the partial isolation of their synovial articular bursæ from the general carpal joint, with which they usually do not communicate.

(4) The metacarpal bone should be enucleated without hacking the interosseous or palmar tissues and without wounding the deep palmar arch. It is impossible to avoid opening the great synovial sac of the carpus if the complete extirpation of the second and fourth metacarpals be undertaken. Hence the great attention to asepsis to avoid septic synovitis of the wrist.

(5) The deep palmar arch crosses the shafts of the second, third, and fourth metacarpal bones close to their bases, and should be avoided.

(6) Each digital artery bifurcates a little more than a quarter of an inch (in adults) above the free edge of the web of the finger.

(7) The metacarpal bones are most accessible from the dorsal side.

(8) The best method of amputating a finger with its corresponding metacarpal is by the racket method, with a long dorsal prolongation, which extends on the dorsal surface from the phalangeo-metacarpal joint to the carpal junction. The palm should always be respected. The bone should be dissected only by enucleation from the base of the finger toward the carpus, the soft parts be cleared by closely hugging the periosteum. By following these rules the only vessels requiring ligation will be the digital arteries at the web. A disregard of this rule will lead to injury of the deep palmar arch and of the interossei, and to troublesome bleeding.

(9) In extirpating the index and auricularis (little finger) incline the dorsal incision upward toward the ulnar side over the base of the metacarpal for the index, and toward the radial side for the little finger. The object of this is to place the sensitive scar as far as possible from the exposed margin of the palm. (See Fig. 259.)

(10) In disarticulating the thumb from the carpus remember the close proximity of the radial artery to the base of the first metacarpal: the artery dips into the palm in the first interosseous space.

(11) In dividing the shaft of a metacarpal the best instrument is a scroll-saw passed under the bone so as to cut upward. A Liston's bone-forceps or metacarpal saw may be used with less advantage, and the soft parts must be protected by a metallic spatula or a retractor passed under the bone.

AMPUTATION OF THE HAND—RADIO-CARPAL DISARTICULATION.

(1) The radio-carpal joint is crescentic in outline, the concavity directed toward the fingers. It is most superficial on the extensor surface.

(2) The top of the styloid process is the best guide to the joint.

(3) The skin on the dorsal surface is scant and lax, and retracts considerably when divided. Three centimetres should be allowed for this retraction (Farabeuf).

(4) Pronation and supination will be affected by disarticulation of the radio-carpal joint, provided the radio-ulnar triangular cartilage be not injured and the small synovial bursa of the lower radio-ulnar joint be respected.

(5) It is easy to mistake the intercarpal joint between the os magnum and semilunar for the true wrist-joint. This can be avoided by extreme flexion of the wrist and determining the position of the styloid process of the radius as a landmark.

(6) The arteries that require ligation are the radial, the ulnar, and the anterior interosseous.

(7) The stump resulting from a wrist amputation should be able to support an artificial hand, and should impart to the apparatus the rotary movements enjoyed by the radius.

(8) So long as a stump has no scar upon its anterior or palmar surface, and especially none over the styloid process (the most exposed friction-point), it will allow of the adaptation of any prosthetic apparatus.

Methods.—The ideal stump is best obtained by the elliptical or oblique circular, which is also practically a long palmar-flap method. The highest point of the ellipse is on the dorsum of the wrist, a little to the inner (ulnar) side of the middle line and half an inch below the line of the wrist-joint; the lowest point is in the palm on a line with the middle finger, and about the length of the diameter of the wrist from the highest point. In carrying the dorsal incision to the palm on the radial side the line should fall over the carpo-metacarpal joint of the thumb, well below the radial styloid. The outline of the ellipse with its palmar prolongation should be first cut with a scalpel from without inward, and the wrist subsequently disarticulated from within outward by cutting the extensor tendons, dorsal and lateral ligaments

while the joint is flexed, and severing the deep flexor tendons close to the carpus as the knife leaves the joint. The stump will present the scar on the dorsum. (See Plate XIII., C and D.)

AMPUTATION OF THE FOREARM.

(1) The normal forearm is an elongated cone in shape, the base of the cone corresponding with the elbow; this makes it difficult to turn up the skin-cuff.

(2) The lower third consists almost exclusively of tendinous masses covered with synovial sheaths, which are easily infected and may lead to rapidly ascending purulent fusees of pus far from the line of section. The tendons are useless as flap material.

(3) The skin on the flexor side retracts much more than that of the dorsum, in the upper third especially.

(4) The arteries are normally the (1) radial, (2) ulnar, (3) anterior and (4) posterior interosseous, (5) comes nervi mediani. (In anomalous arterial conditions as many as eleven arteries have required ligation.)

(5) The Esmarch constrictor must be applied above the elbow.

Methods.—The best is the circular for the lower or tendinous third, and for the other parts, up to the elbow, two equal (antero-posterior) flaps, made by two lateral incisions, on the Ravaton plan. *In the lower third* a circular incision of the skin is made around the limb and dissected up with the fascia one diameter's length from the cut edge of the skin to the future saw line. The cuff of skin is retracted and rolled over. On the level with the retracted skin-cuff the tendons are divided by cutting from without inward or by transfixing them from within outward (the latter procedure is the better). A three-tailed retractor is introduced after the interosseous space is cleared, and the naked bones divided with the saw, the radius first, as it is the movable bone. The limb should be held supine throughout the amputation, as this increases the size of the interosseous space and maintains the bones on the same level. (See Plate XIII., C and D.)

In the middle and upper thirds the circular is the best operation. At these points, where muscles are substituted for tendons, a very short skin-cuff is dissected upward, and the remainder of the soft parts are cut straight to the bone. The soft parts (muscles and skin) are then directly lifted from the bone, including the periosteum, for a distance of one transverse diameter from the cutaneous incision to the point of osseous section. If the limb be shrivelled, thin, and wasted, the soft parts can all be peeled up from the bone without difficulty. In well-shaped muscular limbs the retraction of the soft parts must be assisted by making one internal (ulnar) or two lateral incisions of sufficient length to permit their easy retraction from the bone and interosseous membrane. The retraction of the skin is always very great, so that Farabeuf believes that a full half circumference should be used for each flap. The stump that results from this operation leaves a termino-lateral scar which is so well rounded, padded, and mobile that it never gives serious trouble in after life.

DISARTICULATION OF THE ELBOW.

The exact position of the joint is determined by careful attention to the anatomical relations of the following osseous prominences: (1) The epicondyle or

external condyle of the humerus; (2) the epitrochlea or internal condyle of the humerus, more easily recognized in pathological conditions than the external; (3) the tip of the olecranon.

The external condyle is situated three-fourths of an inch above the articular line; the internal condyle is more than one inch above. The humero-radial joint forms a straight line; the humero-ulnar, an inverted V, owing to the projection of the coronoid process, thus: ʌ. When the forearm is extended the *line of the joint is separated from the tip of the olecranon by two finger-breadths.* The joint is *most easily opened* on the *radial* side, and should always be attacked by this route.

The skin of the extensor surface is thin, and retracts but little; that of the flexor side is much more elastic and retracts remarkably, especially on the outer or supinator side. In making circular sections or flaps due allowance must be made for at least one-fourth retraction in the length of the flexor surface, and special provision made to protect the external condyle, which is most liable to exposure by retraction.

The *stump resulting* from a disarticulation at the elbow is exposed to the greatest pressure and friction on the periphery and over the external condyle. The ideal stump should have the line of scar placed behind the humerus or at least within the olecranon fossa. The ideal is impossible to obtain, owing to the constant tendency of the flexor muscles to drag the scar forward, thus tending to leave a purely terminal scar, but yet a very useful stump.

Methods of Election.—The circular operation, if made with a view to compensate for flexor retraction, must be obliquely inclined downward anteriorly, and thus virtually becomes an elliptical or single-flap amputation. It is the simplest operation and yields the best stumps. The surest way to secure ample covering for the articular ends of the humerus is by cutting the lowest section of the ellipse the length of one transverse (transcondyloid) diameter. In an adult this is usually equal to one handsbreadth from the line of the joint to the point of section.

1. *The Anterior Oblique Circular or Elliptical.*—The highest point of the ellipse is behind, over the prominence of the olecranon. The lowest point is on the anterior surface of the limb, a little above the middle of the forearm. (1) A cutaneous elliptical incision is begun over the olecranon and carried down to the anterior surface of the forearm. As the knife crosses the anterior aspect of the limb the forearm is kept extended, with the hand supine. The elbow is again bent as the knife is carried upward to the point of commencement over the olecranon. (2) The anterior flap as mapped out by the incision is completely dissected up with the fascia until the level of the joint is reached, when the muscular layers are cut through to the joint. (3) The joint is opened on the radial side and disarticulated. (4) The triceps is divided. (5) After the ligation of the brachial the anterior long flap is turned back and sutured to the upper or posterior angle of the incision.

(2) *Posterior Oblique Circular.*—(1) Determine the joint lines; (2) flex the forearm to an angle of 135°; (3) begin an oblique incision from the line of the joint, in form outward and backward, terminating posteriorly a handsbreadth under the tip of the olecranon on the dorsal side. Complete the incision by carrying the knife up to the starting-point in front of the joint. When the forearm is flexed at the angle indicated the direction of the anterior incision is parallel to the prolonged axis of the arm. The dorsal flap with the periosteum, the attachments of the triceps and anconeus, are forced beyond the tips of the olecranon and the dorsal surface of the humerus. In front the soft parts with the joint capsule are divided transversely, the flesh being lifted and the knife carried into the humero-radial articulation. With the division of

the tense internal ligament the operation is finished. Ligation of the brachial artery is made at the bend of elbow (Plate XIII., E and F).

The Arm.

(1) The arm is almost perfectly cylindrical in outline, hence most favorable for the circular method. (2) The retraction of the soft parts is notably greater on the flexor side. The important vessels lie on the inner side.

Rule : Save all that you can up to the surgical neck of the humerus.

Prophylactic hæmostasis is secured by elevation of the limb and applying the elastic constrictor over the acromion, and holding it in position by the hand of an assistant when the upper third is involved. For the lower and middle thirds circular constriction on a level with the lower border of the axilla is applicable here as usual.

The **classical methods of election** are, for the *lower third*, the circular, obliquely inclined downward, on the antero-internal surface, to compensate for flexor retraction ; for the *middle*, the antero-posterior flap method ; for the *upper third*, a racket or oval, or the external-flap method of Farabeuf.

The *circular method*, obliquely inclined to compensate for retraction, with an external liberating incision to facilitate the separation of the soft parts, as advocated by Wyeth, is the simplest, and yields perfectly satisfactory results at any level, and is here recommended in preference to all others.

Steps.—(1) Make a circular incision through the skin fascia with a scalpel ; dissect this up a short distance (one-fourth the length of the flap), and allow it to retract ; (2) cut the muscles and all soft parts squarely to the bone ; (3) elevate all the soft parts, including periosteum (except in children), up to the saw-line, which should be at a distance of one transverse diameter of the limb from the line of cutaneous section.

The resulting stump will be a rounded, well-padded, mobile stump. The scar will be terminal and anterior, owing to the excessive retractile tendency of the flexor muscles.

Disarticulation of the Shoulder.

The scapulo-humeral joint is easily recognized and easily disarticulated. Its weakest and most exposed surfaces are on the anterior and external aspects of the shoulder. Prophylactic hæmostasis is a primary consideration. The important axillary vessels and nerves lie on the inner or axillary aspect of the joint. To control the axillary artery several procedures have been recommended : (1) Digital or mechanical compression of the subclavian in the supraclavicular fossa ; (2) preliminary ligation of the axillary ; (3) primary disarticulation of the humeral head without severing the internal axillary flap (which contains the nerves) until this has been grasped and compressed by the fingers of an assistant. All these are unreliable, and have yielded to two hæmostatic procedures which control the bleeding in all cases : Whenever the shaft of the humerus is intact or is preserved up to the deltoid insertion, the elastic constrictor is applied over the shoulder and vertically across the axilla, and, securely clamped or fastened over the acromial end of the clavicle, will entirely control the axillary vessels, *provided these are ligated at the point of humeral section before the disarticulation is effected.*

Of the thirty-six methods mentioned by Lisfranc and twenty-eight figured in Farabeuf's *Atlas*, only one will be considered, as it is the simplest, most satisfactory, and generally applicable. This is the *circular with a vertical anterior or external incision.* In its result this is essentially equivalent to Spence's anterior and Larrey's external " racket "

methods. The difference lies simply in the fact that the angles of the modified circular are rounded in the racket (Plate XIII., F).

The Modified Circular.—*Steps.*—(1) Elevate and milk the limb to drain out the blood, or apply the Esmarch bandage; (2) apply an elastic constrictor across the axilla, and secure it by tying or by a clamp above the shoulder; (3) make a horizontal circular incision on a plane a little below the anterior axillary border; (4) dissect the skin a short distance and allow it to retract; (5) with the arm held in adduction cut all the soft parts to the bone; (6) dissect the soft parts *in solido* from the bone, especially on the axillary aspect; and (7) find the axillary artery and vein, which must be ligated on a level with the transverse line of section:

Fig. 260.

Esmarch's strap applied in high amputation of the arm (Smith).

this will protect the patient from all dangerous hemorrhage; (8) make a vertical incision extending from the anterior border of the acromion externally to coronoid process and a little external to pectoro-deltoid groove, cutting closely to the bone until a junction with the horizontal circle is effected; (9) dissect up the solid musculo-cutaneous flaps in each side of the vertical incision, thus completely enucleating the bone and exposing the joint; (10) disarticulate by opening capsular ligament and detaching the scapulo-humeral group of tendons.

No vessels of importance, except possibly a circumflex branch, will now require ligation, even if the constrictor should slip when disarticulated.

The principle involved in this procedure is essentially that of Fourneaux Jordan's disarticulation of the hip—*i. e.* to enucleate and disarticulate the humerus after securing the vessels at their peripheral section, while these can be controlled by the constrictor.[1]

Wyeth's Method.—When after excision of the humeral head an amputation becomes necessary, or when the limb has been torn away so that an insufficient support is given to the elastic constrictor, and this is likely to slip over the stump after disarticulation, it will be safer to introduce a large mattress needle through the anterior axillary fold and another through the posterior fold, on the plan advocated by Wyeth in disarticulating the hip, for the purpose of preventing the elastic band from slipping over the stump before the vessels can be securely ligated.

[1] The method is identical with that originally suggested by Ravaton for disarticulating the hip; Jordan simply modernized the procedure. As described above, it is the operation practised by Esmarch and others.

Amputation of the Entire Upper Extremity, including Parts of the Clavicle and the Whole Scapula (Interscapulo-thoracic Amputation).

In the typical operation the whole limb is removed with the scapula and outer two-thirds of the clavicle. The external incisions have been materially modified by Chalot, Kocher, and others. Only the Berger-Farabeuf operation will be here considered.

Steps.—(1) The clavicle is exposed, and is divided at the juncture of the middle with the inner thirds. The middle third is excised. The subclavian vessels are exposed and secured by a double ligature and divided. (2) An antero-inferior flap is cut, which, beginning at the point of clavicular section, is carried in a curve downward and outward along the outer edge of the delto-pectoral groove, under the axilla to the edge of the posterior axillary fold. (3) A postero-superior flap is fashioned by continuing the axillary incision previously described downward and inward, to stop over the posterior surface of the inferior angle of the scapula. In the last part of its course the knife follows the groove between the vertebral border of the scapula, and cuts through the muscular mass formed by the teres major, latissimus dorsi, etc. (4) After cutting through all the soft parts and securing the supra-scapular arteries the extremity is removed by dividing the tissues still connecting the scapula to the trunk.

B. Amputations of the Lower Extremity.

The Foot.—*General Considerations.*—The operator must always bear in mind that the foot is essentially—

(1) An organ of sustentation or support and of locomotion ;

(2) A tactile organ ;

(3) And, exceptionally, a prehensile organ.

The two last functions are not essential to easy locomotion, and can be dispensed with in the ordinary occupations of civilized man. The hand, *per contra*, is essentially a prehensile and tactile organ capable of the most highly differentiated mechanical functions. No artificial appliance can be efficiently substituted for an amputated hand. It is easy to replace an amputated foot only by an efficient artificial substitute, provided a perfectly healthy and painless stump is left after an amputation. No partial or complete amputation of the foot can be made physiologically useful to the bearer unless it complies with the following conditions:

(1) It must be provided with a perfectly sound pressure-bearing plantar surface, which can bear the body's weight and resist the constant friction of standing and walking in active life without undergoing pathological changes—viz. ulceration and neuralgia.

(2) This result can only be obtained by adopting such a method of amputation as will give (*a*) an ample covering to the bones bearing the body pressure ; (*b*) that will solely utilize plantar flaps, which are alone capable of bearing the body weight ; (*c*) that will place all scar-tissue in the most protected locality—*i. e.* the dorsum of the foot. These conditions must be complied with or the foot-stump will be useless as a base of support and will be a source of perpetual distress to the bearer. Hence the extreme conservatism advocated in dealing with the upper extremity can be disregarded in the foot whenever the injury or disease will not permit the surgeon to comply with these essential conditions. Every other condition must subordinate to the one essential requisite—*i. e.* to leave a useful walking stump. Hence the key to success in all methods of amputation of the foot will be found in the ruling principle—a sufficiency of plantar flap to permit the cicatrix to be placed on the dorsum of the foot.

Amputations of the toes are almost always disarticulations, owing to the shortness of the phalanges. Every care must be taken to save as much of the metatarsus, and especially of the first metatarsal and phalanges of the great toe, as possible. The same care need not be taken to preserve every possible part of the four outer toes. "A sloughing stump has often resulted from trying to preserve these almost useless digits."

(1) Interphalangeal disarticulations are best effected by cutting a long plantar flap (Lisfranc's), which will leave the line of scar on the dorsum.

(2) Metatarso-phalangeal disarticulations are made by the oval method.

Method of Election for the Big Toe.—By internal plantar or oval flaps prolonged on the mesial side to thoroughly protect the metatarsal head. Leave the cicatrix in the interosseous space (Plate XIII., G).

Disarticulation of the little toe at the metatarso-phalangeal joint. The same principles apply in this toe, modified to protect the exposed outer side.

Disarticulation of all the Toes at the Metatarso-phalangeal Joint.—A continuous dorsal incision and complete musculo-cutaneous flap on a level with the interdigital web. On the inner and outer border the incision is shaped so as to cover efficiently the heads of metacarpals. The cicatrix must lie entirely on the dorsum.

Amputation of a Toe with its Corresponding Metatarsal.—A racket incision, a prolongation that reaches the corresponding tarsal (cuneiform) joint. In each case enucleate the metatarsal subperiosteally through a purely dorsal incision. Remove only the bone ; level all the soft parts behind. In the case of the first and fifth metatarsal bone incline the racket so that the scar will be mesially inclined and removed from the edge of the foot (Plate XIII., G).

Partial Tarsal Amputation of the Foot.—A great many typical operations have been described by operators for the partial amputation of the foot at the metatarso-tarsal, medio-tarsal, and other joints, all based upon the fundamental idea that the foot is composed of many bones which are held together by numerous complicated joints that must be respected by the surgeon. While this idea is entirely correct from the anatomist's point of view, it should be entirely disregarded by the surgeon whenever the exigencies of conservative surgery demand it. There is no special advantage in following articular lines. It is hard to break through surgical traditions that have been handed down from generation to generation, but it is nevertheless wrong to sacrifice even a quarter inch of foot-tissue for the mere sake of following a classical procedure. As Agnew taught long ago in this country and others elsewhere (Guérin, Mayer, Kocher), the skeleton of the foot must be considered a surgical unity to be treated by the knife and saw, just as the femur or humerus would be, at the exact point which will yield the longest and most useful stump to the patient. What is essential in every case is the application of the principle of plantar flaps—preservation and scar-protection.

Some surgeons and artificial-limb manufacturers have lately boldly urged the complete abandonment of all tarsal and tibio-tarsal operations. Truax, whose large experience as a mechanic entitles his views to special consideration, has thus formulated his opinion : "Avoid

amputation within three inches of the ankle-joint. Do not amputate between the metatarsal bones and the junction of the lower and middle thirds of the tibia. At all other points save all you can, and you will in every case have done the best for your patient." This would exclude all conservative foot operations, from Lisfranc's joint (tarso-metatarsal) up to the point of election in the leg.

The reasons given for this extreme view are that all these tarsal operations sever the flexor and extensor tendons of the foot and cut through its arch, thus destroying its elasticity as well as nearly all its power of flexion; that the foot is so shortened that when in an active state at the time when the limb is inclined obliquely backward, it cannot be used as a lower or main propelling power by which the body is advanced to a position perpendicularly over the forward limbs. This is important, for the loss of a portion of the foot in most cases necessitates the taking of a shorter step and a greater flexing of the knee of the said limb. This raising of the body with every step requires additional labor and causes the limp so noticeable in this class of cases.

It is also argued that it is much more difficult to adjust a well-fitting artificial limb to a partially amputated foot than it is to the leg-stump after amputation at the point of election, and that, finally, a well-made artificial foot, with its perfect mechanical ankle, is free from all the objectionable features of the partially amputated foot. With the artificial foot the patient does not limp, and he walks so perfectly that it is impossible to discover by mere inspection that he wears an artificial substitute for the lost limb. Other prosthetic mechanics, on the other hand, contend that the mechanical difficulties in the way of adjusting proper artificial substitutes for partially amputated feet are not insurmountable, and, in fact, are readily overcome, so that a patient with a partially amputated foot can be made to walk as gracefully as well as when the original natural limb existed.

Granting the contention that partially medio-tarsal stumps are more difficult to treat prosthetically than sound leg-stumps, and that it is true that an artificial foot can be made to walk more elegantly and naturally than a partially amputated foot without prosthetic compensation, we must still remember that hundreds of men walk painlessly and comfortably upon medio-tarsal stumps without the help of any artificial substitute, and that if they do limp, they are nevertheless not abjectly dependent on an artificial limb, which is costly and must be renovated at intervals. With the poor and dependent, who find it practically impossible to economize, this is a matter of serious consideration.

We would therefore formulate the following rule:

Amputate the foot conservatively—save all you can whenever a sufficiently long *healthy plantar* or *heel* flap can be obtained. If the proper flap material be wanting and scar-tissue must remain on the exposed plantar surface, amputation above the malleoli or at the prosthetic point of election in the leg (junction of lower and middle thirds) of tibia. Medio-tarsal or intramalleolar stumps, if properly made, if painless and healthy, will be equally useful to the poor and the wealthy—to the poor man, because he will be able to walk independently of an expensive artificial limb; to the rich man, because he will be able to adopt a compensating appliance that will disguise his deformity.

In all of the partial amputations of the foot a long plantar and a short dorsal flap—cut from without inward—should be made before sawing or disarticulating the soft parts.

Through the Metatarsus.—By sawing transversely at any level up to the tarso-metatarsal or Lisfranc's joint (Plate XIII., H).

Typical Tarso-metatarsal Disarticulation—(Lisfranc's, 1818).— The anterior part of the foot is removed; the seven tarsal bones are left in the stump. The plantar flap extends to the middle of the balls of the toes. The joint line is indicated laterally by the tuberosity of

the fifth metatarsal, behind which lies the line of the joint. On the inner side a small eminence, the base of the first metatarsal, is distinctly palpable. The line of the joint is convex downward and outward, and has a depression above, due to the recession of the second cuneiform bone, which lies back of the general articular line 2 to 3 cm. The strongest ligament is between the first cuneiform and base of the

Fig. 261.   Fig. 262.

Tarso-metatarsal disarticulation (Farabeuf).   Stump after same.

second metatarsal (Lisfranc's ligament), and until this is severed (the master-stroke) the joint cannot be made to gape. As in all operations of the foot, the vessels are preserved in the plantar flap, great care being taken not to injure them, on a level with the divided bone.

Lisfranc's operation is an admirable exercise on the cadaver, but it is rapidly becoming historical in practice, an even and simple saw section being substituted with advantage for the more difficult disarticulation.

Modifications are numerous; the best known are simply mentioned for convenient reference.

Hey's (1799).—Disarticulated on the metatarso-tarsal joint, as in a typical Lisfranc, up to the first metatarso-cuneiform joint, when the projecting end of the first cuneiform was sawn through and excluded from the stump with the corresponding metatarsal bone.

Bauden's.—The first metatarso-cuneiform joint is disarticulated, and the saw is carried transversely through the bases of the four remaining metatarsals.

S. Key's.—The whole tarso-metatarsal joint is disarticulated except the second metatarsal, the base of which is sawn through on a level with the first metatarso-cuneiform joint, and allowed to remain in its mortise.

Medio-tarsal Disarticulation.—(**Chopart's Operation**, 1787).—In the typical operation the astragalus is disarticulated from the scaphoid, and the calcaneum from the cuboid. The astragalus and calcaneum are the only two bones left in the stump (Plate XIII., H).

The line of the joint is indicated on the inner side by the marked projection of the tuberosity of the scaphoid bone, behind which it lies, and on the outer side by a tubercle on the body of the calcaneum, which lies just behind the calcaneo-cuboid joint. An oblique circular

or elliptical incision strikes the line of the joint on the dorsal aspect, and passes behind the balls of the toes on the plantar surface. Two short dorso-lateral incisions facilitate the exarticulation (Kocher).

The main connection between the bones is the Y-shaped ligament from the body of the calcaneum to the scaphoid and cuboid.

The operation has often resulted in a bad stump, owing to equinus position of the foot and chafing at the anterior and inferior angle of stump, especially when the scar is left too low anteriorly. The best preventive measure for this is to attach the dorsal extensor tendons firmly to the stump, prophylactic tenotomy of the Achilles tendon, and primary union to reduce to a minimum the amount of scar-tissue.

As in Lisfranc's operation, the saw can be carried through the line of the joint without regard to the articular lines, any loose or thin shavings of bone or carti-lage that may remain being removed after the section. The astragalus may be cut through with saw 1 cm. behind Chopart's astragalo-scaphoid joint, without impli-cating the ankle, thus ensuring still a movable stump.

Modification.—(1) Albert of Vienna endeavors to counteract the retractile tendency of the Achilles tendon by a special procedure. He cuts the tendons of the common extensor of the toes two inches below the line of the dorsal flaps. The joint between the scaphoid and cunei-form is opened, the cuboid being sawn through as in Forbes' amputa-tion. Two holes are bored—one through the scaphoid, and the other through the cuboid. The extensor tendons are passed through these perforations and sutured to the plantar fascia. In this way the exten-sors retain a firm control of the plantar end of the stump and the mus-cular equilibrium is maintained.

(2) Forbes and Bona saw through the cuboid and disarticulate the scaphoid from the three cuneiforms, thus leaving three and a half bones in the stump.

(3) Jobert disarticulates the scaphoid from the cuneiforms, and the cuboid from the three last metatarsals.

(4) Laborie separates the scaphoid from the three cuneiforms, and the cuboid from the calcaneum.[1]

Subastragaloid disarticulation consists in disarticulating the astrag-alus from the calcaneum and cuboid. It leaves only one bone of the foot in the stump.

The original operations proposed by Lignerolles (1839) and Textor (1841), subsequently popularized by Malgaigne, and the numerous modifications that have followed, can be resolved into two methods of cutting the soft parts: (*a*) The oval or racket; and (*b*) the heel-flap method. The *oval incision* begins horizontally under the tip of the external malleolus, extending toward dorsum to Chopart's line (which is distinctly marked, as above, by the tuberosity of the scaphoid), along which it descends vertically to the sole on the internal side, back to the point of beginning on the outer side. Chopart's joint is opened from above between the head of the astragalus and the scaphoid. Then, without penetrating deeper into this joint, the narrow knife is turned immediately upward and back-ward under the head of the astragalus, so as to sever the strong interosseous astragalo-calcanean ligament in the sinus tarsi, and the calcaneum is enucleated close to the periosteum in the upper, outer, and lower surface, then inward, and lastly posteriorly. On the inner side the most difficult step is the separation of the sustentaculum tali, which extends high up. When the skin-covering is insuf-ficient the head of the astragalus is sawed off (Kocher).

[1] Other modifications could be multiplied, but these are amply sufficient to empha-size the great utility of the doctrine of the unity of the foot, which teaches that we must disregard articular lines, and thus simplify the practice of conservatism.

Modification.—(*a*) Baudens (1848) sawed the inferior surface of the astragalus in a horizontal plane to create a flat resting surface.

(*b*) Hancock (1864), after a horizontal section of the astragalus, sawed through the calcaneum and attached the remaining portion of the bone to the astragalus on the Pirogoff plan.

(*c*) Roux and Blasius cut vertically through the head of the astragalus and anterior portion of the calcaneum without disturbing the joint between them.

(*d*) Tripier sawed the calcaneum horizontally just below the articulation of this bone with the astralagus. The joint is respected, and a thin horizontal section of the os calcis remains attached (articulated) to the astragalus.

Perrin, Verneuil, Farabeuf, and others have modified the cutaneous incisions in various ways with the view of utilizing the soft parts to the best advantage, but the essential principles are the same in all—viz. to attack the joint always on the outside—to be extremely careful not to injure the vascular (nutrient) internal flap and the necessary heel surface, so that a healthy, resisting, walking surface may be preserved. A failure to comply with these conditions means a worthless stump and a secondary amputation.

Tibio-tarsal Amputation.—Total amputation of the foot (**Syme's** operation). In the original operation the whole skeleton of the foot is removed, including the ankle-joint with the malleoli. The cutaneous hood of the heel, which contains the calcaneum, alone remains as a flap with which to cover the sawn surfaces of the tibia and fibula. This is still a very useful operation (Plate XIII., H).

(1) The foot is held flexed at right angles with the leg. A deep incision is made, penetrating to the bone throughout its course from the apex of one malleolus to the other, crossing the sole of the foot transversely. (2) The foot is lowered, pressed strongly downward, and a second incision made transversely across the anterior surface of the ankle-joint from the apex of one malleolus to the other, joining the vertical with the horizontal incision. (3) Open the ankle anteriorly; circumscribe the malleoli; divide the lateral ligaments; dislocate the astragalus forward. (4) The os calcis is now exposed by traction, and the heel-cap is carefully peeled away with the knife from the calcaneum, being extremely careful not to buttonhole it. The heel-cap can be dissected or peeled off first before opening the ankle. (5) Retract the heel and all soft parts away from the tibia and malleoli, and run a saw transversely just above the articular line of the tibia, thus removing the malleoli. The cartilaginous surface may be left behind, and the malleoli alone removed. (6) The hood of the flap is now raised and sutured over the divided tibia to the anterior skin of the leg. If drainage be required, tap the heel-cap on the outer side of the tendo-Achilles attachment; never perforate the plantar or active surface of the stump.

Special Recommendation.—Never cut obliquely backward on the inner border of the heel-flap, or encroach upon this beyond the vertical line indicated, for fear of mortification through injury to the posterior tibial and plantar vessels (Wyeth).

Pirogoff's Modification.—The leg-bones are sawed off by a Syme's operation just above the articular line, and to the sawed surface is attached a posterior section of the tuberosity of the calcaneum. The preservation of this part of the os calcis has the great advantage that the skin of the heel remains well nourished and the so-called heel-cap remains filled. With Kocher, Wyeth believes it preferable to Syme's disarticulation as a walking stump.

Modifications.—Roux and others have modified Syme's operation by an oval incision which utilizes the internal and plantar surfaces of the foot, so that the cup of the heel is divided, and still a walking plantar surface is retained. The incisions are very much as in subastragaloid by oval section.

Pirogoff's operation has been modified by making a horizontal section of the os calcis instead of the vertical division in the original operation (Pasquier and LeFort), or by making a curved section of the calcaneum, to be adjusted to a convex section of the tibia and fibula (V. Bruns), or by cutting the os calcis obliquely to fit an oblique section of the tibia (Gunther). The original simple vertical section is the simplest and most readily executed. Tauber, Chaput, and others saw the os calcis vertically in two halves, and turn up the internal sawed surface and attach it to the horizontal section of the bones of the leg.

These modifications are all intended to favor the closer approximation of the sawed calcaneum to the leg-bones, but they are of doubtful utility.

Other atypical conservative operations on the foot have also been devised to meet certain unusual pathological or traumatic conditions (Plate XIII., I.).

Anterior osteoplastic tarsectomy, leaving the plantar surface untouched, but shortening the foot (Link's operation, 1887). (See Fig. 263.) This

Fig. 263. Fig. 264.

Link's osteoplastic substitute for Chopart's amputation (Chalot).
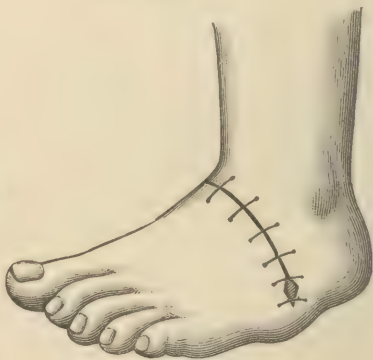
Same, showing result.

is indicated wherever the dorsum of the foot is injured or diseased and other parts are sound.

Posterior osteoplastic tarsectomy has been already described (p. 645, Vol. I.).

AMPUTATION OF THE LEG.

In olden times, when the injury or disease was below the knee it was customary to amputate at the upper third of the leg, with the view to flexing the knee-joint and resting the body on the knee on the generally used peg leg. If the injury were at or near the knee, then, when possible, at the lower third of the femur, as giving the best stump or one most easily fitted to a conical socket, and which would support the necessary pressure on the sides of the stump in walking. In these days, however, the peg leg is rarely seen except among the extremely poor class (the indigent negro population of the South most often), and the mutilation is not so palpably advertised. With the great advances accomplished in the last few years in the manufacture of artificial limbs, and the great reduction in their cost which has made them attainable by almost all classes, the old points of election have radically changed and the technique of amputations, especially of the lower extremity, has been more than ever subordinated to the exigencies of the prosthetic art.

It should be remembered that in amputations through the continuity of the leg the weight of the body is borne by cone-shaped sockets which hold the stump very much as if we attempted to lift a person from the floor by grasping the leg below the calf with both hands. The pressure is therefore circumferential, and in the leg the greatest friction- and pressure-point is in the antero-inferior surface of the stump, which is chiefly used in lifting the artificial leg in walking.

Diametrically opposed to the old teaching, we now understand that we cannot have too much natural leg. It is the lever that controls the artificial part, and the longer the lever the better the walking results.

While the majority of skilled mechanics agree that it is possible to fit an artificial limb to any length of leg, it is admitted there are some bone-sections that are much more desirable than others from the purely prosthetic or mechanical point of view. Thus, instead of considering the point of election to be a handsbreadth below the knee-joint, as it used to be, the *ideal point of election is now placed at the junction of the middle and lower thirds of the tibia*—the point of election, be it understood, only referring to the bone, and not the soft parts. This leaves space enough underneath the end of the stump for the placing of an artificial joint of the most approved pattern, giving a stump of ample length to provide sufficient leverage to enable the patient to easily swing a substitute, besides leaving the calf in a cone shape, that it may be made to assist the head of the tibia in supporting and carrying the weight of the body.

The *tibia* of an adult *should not be amputated* at a point *less than two and a half or three inches from its upper articular surface*, as it will flex under the influence of the stronger flexors. The knee will be useless as an articulation, but it will make an excellent stump, as it gives the best possible support.

Bearing in mind that the most active surface of the stump left after a leg amputation is its antero-inferior angle, the greatest care should be observed in securing a stump that will exclude most rigorously all sensitive and weak scar-tissues at this point. Hence all operations must be rejected which systematically throw the cicatrix in front of the shin. The methods which are best calculated to meet *the essential condition*— the line of scar posteriorly placed—are : (1) *The modified circular* (also called bilateral) *flap* of Stephen Smith ; (2) *Bruns' circular* (*oblique*), with lateral liberating incisions which convert the stump into an equal (quadrangular) antero-posterior flap operation ; (3) *the long anterior and short posterior flaps*, curved or quadrangular (Teale's) ; (4) *the long antero-external ;* (5) *the simple long anterior flap* (Bell).

The only exception to the general rule is in the supramalleolar amputations, where Guyon's very elliptical flap, borrowed from the heel, can be turned forward, so that the thick heel-skin lies in front and under the tibia, where it is capable of sustaining considerable pressure.

Any of these methods will yield admirable stumps, provided the following conditions are complied with : (1) That there shall be an ample sufficiency of well-nourished flaps; (2) that the projecting antero-inferior angle of the tibial crest be rounded off; (3) that the fibula be cut at a higher level than the tibia, so as to favor a conical formation of the stump; (4) that the scar-tissue be kept away from the antero-inferior angle or surface; (5) that the end of the stump be mobile and not adherent to the bone (which is best obtained by retaining solid musculo-cutaneous flaps and periosteal cuffs) ; (6) that the nerve-trunks be cut high up above the peripheral line of pressure.

At the Supramalleolar Point—Guyon's Amputation (see Fig. 265).—Make an elliptical cutaneous incision which crosses the heel below

the tendo-Achilles attachment, and reaches a point one inch above the lower articular edge of the tibia anteriorly. Dissect up a solid flap posteriorly from the heel, cutting through the tendo-Achilles at its insertion, hugging the bone all the way. Divide the anterior extensor ten-

FIG. 265.
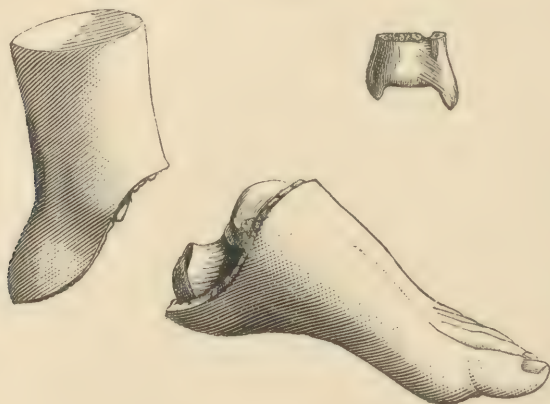
Guyon's supramalleolar amputation (Farabeuf).

dons transversely—by transfixion preferably—and saw the bones above the malleoli, so that the lower or heel end of the ellipse may be brought distinctly forward. Be careful to cut the post-tibial nerves high up, so that they shall not be exposed to pressure.

At the Point of Election (junction of middle and lower thirds of tibia) (Plate XIII., I.).—Commence an incision with a large scalpel in the centre of the anterior surface, and carry it downward along the side of the leg, so as to make a slightly curved flap with its convexity below : when the incision passes over the prominent part of the leg toward the posterior surface, incline it upward until the middle of the limb is reached, where it should be continued directly up (on the racket plan) to the point at which the bone is to be divided ; make a similar incision on the opposite side. Dissect the skin up to the extent of one inch in the adult leg (two inches in the thigh). Now make a circular division of the muscles to the bone with a long knife. Saw the bone at this point, and direct an assistant to seize and hold the extremity firmly with strong bone-forceps. With the elevator raise the periosteum from the tibia to the point where the latter is to be cut ; divide the bone again at the base of the periosteal flap (half a transverse diameter of leg from edge of retracted flap to the last saw-line). The fibula must be cut at a higher point. The Gowan-Wyeth exsector is advantageously used here : a narrow metacarpal saw, or even a chain-saw, will effect the division of the fibula with little injury to the soft parts.

The stump left by this amputation is covered by the integument internally, the periosteum externally (in young children the periosteal cuff is not desirable, as the bone is reproduced too rapidly and a pathological conicity of stump will result), while the intervening tissues—muscles, vessels, and nerves—have not been disturbed in the dissection. The periosteal flap falls like a hood over the end of

the bone; the skin-flaps lie in contact without tension; the drainage is direct from the angle behind. When cicatrization is complete the cicatrix lies posteriorly to the end of the stump; the terminal cushion is freely movable, and the bone does not undergo the usual amount of atrophy.

This method is described in detail, owing to the importance of the correct principles of flap-formation that it illustrates in this most important region. This method of amputating is much more tedious than the old rapid circular with cuff or flaps, and is therefore not very popular with the rapid amphitheatre teachers of the old school, but the admirable stump that results from it amply compensates for the time taken in its execution.

In this, as in other solid flap or periosteal operations, the metallic retractor shields of McCurdy will be found to be of some service in protecting and retracting the soft parts.

Bruns' Method.—Draw the skin up strongly and make an oblique circular incision down to the bone at a distance below the future saw-line equal to two-thirds of the diameter of the leg at the saw-line. Liberating incisions, about two inches for adults, are carried upward from the circular incision, dividing all the soft parts over the inner border of the tibia and the outer aspect of the fibula. Without disturbing the attachments of the skin and underlying soft parts, the

Fig. 266.   Fig. 267.
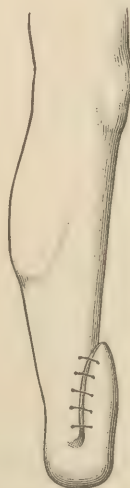
Keetley's dermatoplastic amputation of foot, necessitated by extensive ulcer (Chalot).

periosteum is carefully raised from the tibia and fibula as high as the lateral liberating incisions extend, and first the fibula and then the tibia are sawn through. The tibia, as in other operations, is cut obliquely to prevent angular projection of the crest. This amounts to a subperiosteal excision of the bones of the leg, and leaves an exceedingly serviceable and well-protected stump. The angles of the flaps can be rounded off if preferred. When finished this leaves a double antero-posterior flap stump.

Atypical Methods.—In conditions which admit of supramalleolar amputations in the poor class it is desirable to obtain, if possible, a pressure-bearing stump upon which the patient can walk without the necessity of wearing expensive

apparatus. When a good heel-flap can be obtained Guyon's method (Fig. 265) will be all-sufficient. Nevertheless, Bier of Kiel has attempted to solve the problem by chiselling a piece of the tibia and placing it horizontally against the remaining end of the bone, so as to form a kind of artificial foot. This shortens the leg too much, and is hence worthless. Kummer of Geneva proposes to preserve a long posterior heel-flap which remains attached to the leg, but not attached to the bone, until a perfectly healthy granular surface has formed. This is usually in four and a half weeks, during which time the flap shrinks up considerably, and allows itself to become attached to the bone surface by secondary sutures (Plate XIII., I and K).

THE KNEE.

When disarticulation has been decided upon, it is best, if possible, to follow Brinton's suggestion (1872) to preserve the semilunar cartilages. By this means the ligamentous covering of the knee is preserved, and all the fascial relations are preserved intact, which eventually prevents retraction and guards against the projection of the condyles. This is totally contrary to the opinions of prosthetic writers of authority, who advocate a total abandonment of disarticulation at the knee, and who, judging purely from the standpoint of mechanical convenience and

FIG. 268.
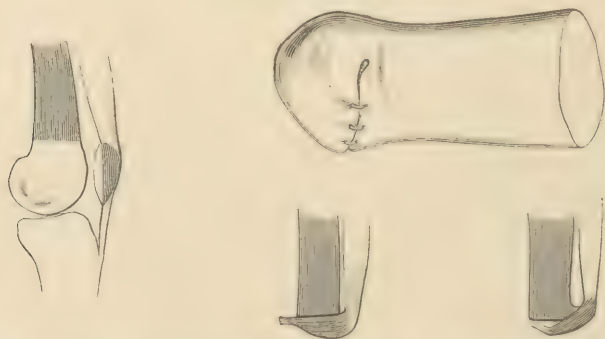
Gritti's osteoplastic supracondyloid knee amputation : patella utilized (Farabeuf).

economy, universally claim that the *ideal* knee operation and point of selection should be three inches above the joint, and that Gritti's supracondyloid operation affords much better stumps than a simple disarticulation (Fig. 268). All prosthetic mechanics do not deny, however, that a simple knee disarticulation offers any insurmountable obstacles to successful prosthesis, and, as this operation is unquestionably superior from the anatomical and surgical (conservative) points of view, we shall give it due consideration (Plate XIII., I and K).

The *advantage of disarticulation* over the simpler and more brilliant-looking amputation through or above the femoral condyles are many and striking :

(1) There is less shock, less hemorrhage, less loss of limb, and less liability to infect the connective-tissue planes or marrow-canal ;

(2) Important muscular attachments are left undisturbed, and there is little muscular retraction ;

(3) The stump is an excellent one, capable of great mobility and of bearing direct pressure.

The *conditions for a successful disarticulation* are—(1) That the joint must be absolutely healthy, free from injury, disease, or infection ; (2) that the necessary ample flap can be secured from the anterior

surface of the leg to thoroughly cover the large condyloid surface without tension; (3) that the patella and semilunar cartilages should be retained (this is not absolutely necessary, but desirable); (4) that the anterior surface of the stump shall be free from all scar-tissue.

The length of the anterior flap-covering can be readily estimated by cutting a flap from the anterior surface of the leg, which shall measure the length of the transcondyloid diameter of the femur, from the line bounding the patella to the point of anterior section in a semiflexed position of the limb. This will correspond, as a rule, to a point one inch below the tubercle of the tibia and will furnish ample covering for the condyles.

Methods of Election.—Stephen Smith's Bilateral (or "hooded flap") Method.—With a large scalpel commence an incision about one inch below the tubercle of the tibia, and cut to the bone; carry it downward and forward beyond the curve of the side of the leg, thence inward and backward to the middle of the leg, thence upward to the middle of the popliteal space. Repeat this incision upon the opposite side; raise the flap, consisting of all the tissues down to the bone, until the articulation is reached, divide the lateral ligaments, and enter the joint and sever its connections internally and externally.

FIG. 269.

Stump after Stephen Smith's amputation at knee.

Be especially careful with the internal flap, which should be prolonged downward a little more than the external to provide sufficient covering for the internal condyle, which is longer and larger than the external.

By this method a well-rounded stump is obtained with a cicatrix sunk in the intercondyloid fossa.

Other methods of disarticulating the knee-joint that also comply with essential conditions of sufficient flap-covering, and that leave the scar-line in the posterior femoral surface, are the anterior elliptical incision (of Baudens), the circular with a posterior liberating incision (Chalot's), the long anterior flap method of Pollock, and the bilateral flap of Pick; but none of these is superior to the hooded flap of Smith, previously described.

AMPUTATION OF THE THIGH.

Through the Condyles.—The osseous section of the femur is made at the base of the condyles, about the level of the tubercle for the insertion of the abductor magnus tendon, or a little above this spot. At this level the medullary canal is not opened, as it begins one or two inches higher in the narrower part of the shaft. The saw-line corresponds to the epiphyseal line, which in children must be removed, for fear of secondary growth of bone and conical overgrowth of stump. If the patella is removed as in Carden's amputation, great retraction must be expected in making the muscular section, and due allowance must be made for this in cutting the anterior flap.

Methods of Election.—*Carden's transcondyloid* (1846) consists in reflecting a rounded and semioval flap of skin and fat from the front of the joint (one diameter's length from the point of osseous section), dividing everything else straight down to the bone, and sawing the bone

slightly above the plane of the muscles, thus forming a flat-faced stump with a bonnet of skin to fall over it. The patella is divided immediately above its upper border, and is thus excluded from the stump.

Lister modified this operation by cutting a short posterior flap.

Fig. 270.
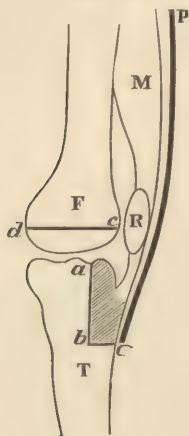
Sabanejeff's knee amputation (Chalot).

Fig. 271.
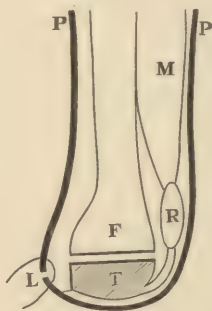
Stump made as in Fig. 270 (Chalot).

Gritti's osteoplastic operation (1857) consists not only in removing the condyles, but also of *sawing the articular surface of the patella* and placing its cut surface upon the sawn condyles for the purpose of securing union of the bones (Fig. 268).

Fig. 272.
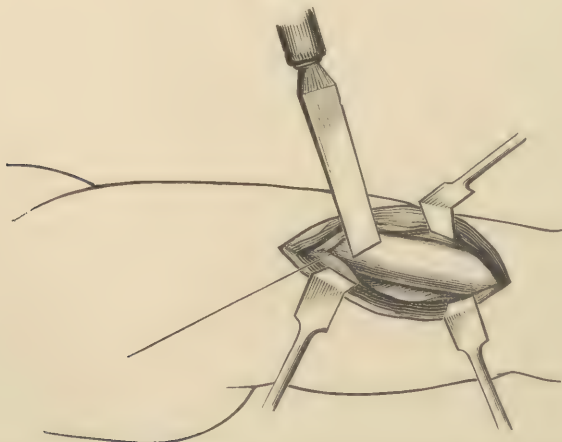
Amputation of thigh by Neudörfer's method: periosteum retracted, chisel applied.

Stokes's supracondyloid modification, which has been generally substituted for the original Gritti, consists in dividing the femur higher up, at a point from one-half to three-quarters of an inch above the condyles. The section of the femur at this level is more nearly equal in size to that

of the divided patella. The patella at this point is not pulled up by the quadriceps as easily as in the lower or transcondyloid section of Gritti.

The bones are kept in position, either by closely suturing the soft parts above the patella to the posterior flap or by wiring; which is unnecessary. Stokes also modifies the section of the soft parts, so that an anterior oval flap is fashioned which reaches from a point one inch above either condyle to a point just below the tubercle of the tibia. A posterior flap is also formed (Gritti cuts only one long anterior flap) which is at least one-third of the length of the anterior flap.

Intercondyloid osteoplastic amputation of Sabanejeff (1890).—In some exceptional cases this operation may find application. It consists in making a section of the femur through the condyles. A section of tibia, including the tubercle with the patellar tendon attached, is then excised and sutured to the sawn femoral surface, as shown in Fig. 270.

Through the Shaft and Upper Portion.—Conservatism should rule here. Save every inch of the femur up to the trochanteric line, and above this line disarticulate at the hip. Every method of amputation has been applied here with greater or less success.

Anatomical Points.—(1) The skin on the inner abductor and flexor surfaces has a great tendency to retraction; hence circular incisions through the lower

Fig. 273.
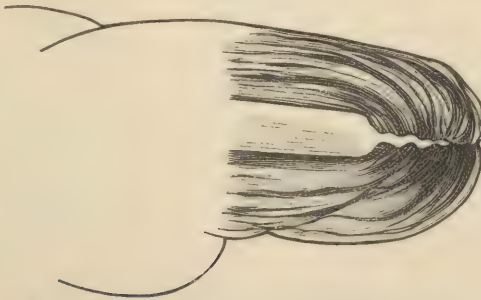
Same: soft parts sutured over the end of the bone.

third should be made obliquely downward to compensate for the unequal retraction of the skin. An oblique section will become a circular after the skin has retracted.

(2) The thigh muscles retract very unequally when divided, this retraction being most conspicuous in the hamstring muscles posteriorly and on the inner side of the adductors, owing to their separate attachment to the pelvis. Hence the suggestion of Dawbarn, Brown, and others to tenotomize the hamstrings before amputation, so that full retraction may take place before the amputation is made.

There are over twenty recognized methods of amputating the thigh, and there is considerable division of opinion among leading authorities as to which should be preferred, the circular or the flap method (Plate XIII., L).

For the reasons given elsewhere we would unhesitatingly recommend the following section of the thigh, from the supracondyloid line of Gritti to the trochanters:

The circular, *modified by giving it sufficient obliquity downward to compensate for the cutaneous and muscular retraction,* and by adding an external liberating incision on the outer aspect of the limb (Wyeth), or by making two liberating incisions on each side from the circular line to the level of the osseous section (Ravaton). Whenever the circular is made, the subperiosteal or paraperiosteal solid-flap section is

referred to with very short skin-cuff. The preferred circular method is identical with that described in the section on methods of amputation.

The **bilateral solid flap** (or hooded flap) method of Stephen Smith. The procedure is the same here as in the leg, and much simplified by the presence of one bone.

Neudörfer's Method.—This is virtually a circular with lateral liberating incisions—only differing in the fact that the osseous section is

FIG. 274.
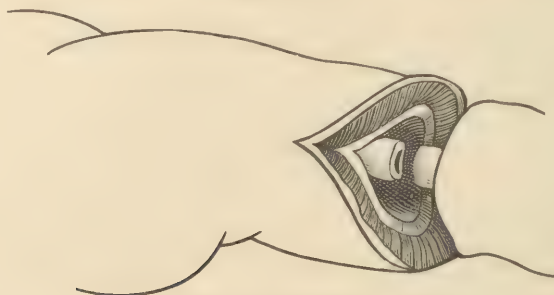
Same: bone divided.

made first and the flaps cut afterward. It is especially indicated when the disturbance of the soft parts and skin must be reduced to a minimum (amputation for senile and diabetic gangrene, etc.).

By any of these three methods perfect, movable, well-protected, and well-padded stumps are obtained. The scar-tissue is all thrown backward, away from the terminus of the stump, owing to the secondary contraction of the flexors and adductors.

THE HIP-JOINT.

Disarticulation at the Ilio-femoral Articulation.—The indications for disarticulation are furnished by all injuries or diseases which implicate the femur up to the trochanteric lines. The notable exception to this rule of conservatism is in malignant disease of bone, especially medullary growths connected with the middle and upper third of the femur. Here the tendency to recurrence will be diminished by disarticulating through the joint.

Anatomical Landmarks.—The hip-joint is most accessible and easily opened from the front. The pubic spine is on a level with the great trochanter. The summit of the great trochanter is on a level with the hip-joint. The important vessels are the femoral and its branches, which lie on the antero-internal aspect of the joint. The femoral is separated from the capsule of the hip by the muscle, upon which it lies. The sciatic and its branches are the most important arteries.

Special precautions must be taken against—(1) *shock;* (2) *hemorrhage.* Thorough hæmostasis is the surest way of preventing shock. Prophylactic intravenous injection of hot normal saline solution (about 40 gr. chloride of sodium to 1 pint) is the most efficient mode of preparing a patient who needs stimulation. In every case in which shock exists, or there is traumatic anæmia from antecedent hemorrhage, inject the saline solution. In every case in which serious shock is apprehended expose the median basilic in the arm, and have it ready to receive the cannula and hot saline solution.

Prophylactic hæmostasis, with the view of controlling the femoral circulation, has been attempted with more or less success by several methods: *Compression of the abdominal aorta* mechanically with tourniquets, Lister's, Esmarch's, etc., or by the hand, of which Macewen's recently proposed method is the best; *compression of the common iliac through the rectum,* mechanically with Davy's lever; with the hand (Woodbury's plan); by direct compression of the iliac trunks intraperitoneally, or extra-peritoneally by compressing the common femoral over Poupart's ligament with the finger; by preliminary ligation of the iliac or femoral arteries and veins; by elastic circular constriction, as adapted from Esmarch by Jordan; by Wyeth's method, transfixing the limb with skewers which are passed transversely through the root of the limb between the joint-capsule and the artery, and compressing the soft parts above with an elastic cord tied in a figure of 8; or by using two skewers, one in front and one behind the femur (Tredelenburg and Newman); or by transfixing the thigh antero-posteriorly (Myles) and applying the figure of 8 laterally; or by a preliminary dissection of the vessels and their compression with a special compressor (Dillon Brown, 1895); or by excising the femoral head by external incision and compressing the anterior and posterior halves of the limb separately with elastic bands (Senn).

All of these methods have been used with greater or less success by their inventors, and may have some advantages in special cases, but none can compare in their general application, thoroughness, simplicity, and wide range of usefulness with Wyeth's method, which must be considered the method of election.

Wyeth's Bloodless Method.—*Steps.*—(1) Expose the median basilic or cephalic in the arm in readiness for saline infusion. Place the patient with the trunk on the edge of the table. Lower the trunk.

FIG. 275.
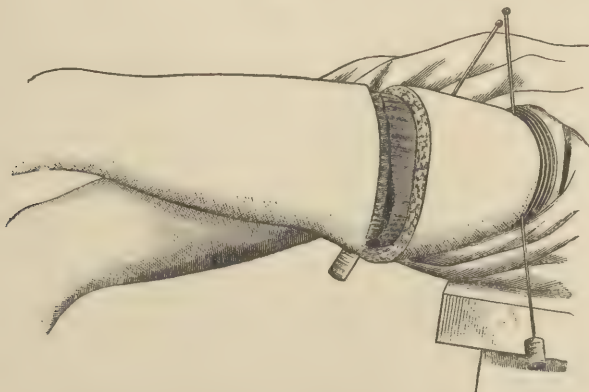
Wyeth's bloodless method: pins inserted and tube applied.

Elevate the limb and milk it to empty it of blood, or apply Esmarch's bandage from toes to trochanters according to general rules.

(2) While the limb is still elevated or the Esmarch bandage is in position a large mattress needle or skewer, about three-sixteenths of an inch

in diameter and ten inches long, is introduced one inch below the ante-
rior superior spine of the ilium and slightly to the inner side of this
prominence. It is made to traverse superficially the muscles and fascia
in the outer side of the hip, emerging on a level with, and about three
inches from, the point of entrance. Another needle is now made to
enter one inch below the level of the crotch internally to the saphenous
opening, and, passing squarely through the adductors, comes out an inch
below the tuber ischii. The points are at once shielded by bits of cork
to prevent injury to the hands of the operator. No important structures
are endangered by these skewers. A piece of strong white rubber tube,
half an inch in diameter and long enough when tightened in position to
go five or six times around the thigh, is now wound very tightly around
and above the fixative needles and tied. If the Esmarch bandage has
been employed, it is now removed. By using the skewers and con-
strictor high up in this way the absolute occlusion of every vessel at the
level of the hip-joint safely above the field of operation is secured, per-
mitting the disarticulation to be completed and the vessels secured before
the tourniquet is removed.

(3) Division of the soft parts. In the formation of the flaps the
surgeon must be guided by the condition of the parts within the field
of operation. When permissible the following method seems ideal:
About six inches below the tourniquet a circular incision is made, and
this is joined by a longitudinal incision commencing at the tourniquet
and passing over the trochanter major. A cuff that includes the sub-
cutaneous tissues down to the deep fascia is dissected off to near the
level of the trochanter minor. At about the level of the trochanter
minor the remaining soft parts, together with the vessels, are divided
down to the bone by a circular cut, and, in order to facilitate the search
for the vessels, the soft parts are rapidly removed from the femur for
several inches below the line of the divided muscles.

At this stage of the operation the large vessels, veins as well as
arteries, should be tied with good-sized catgut. Now leave the entire
extremity intact, and use the full length of the limb as a lever in divid-
ing the head of the bone. When the large and easily recognized vessels
have been secured, the muscular attachments to the extremity of the
bone are lifted off with scissors or knife, keeping along very close to the
bone. After dividing the capsule of the joint forcible elevation, abduc-
tion, and adduction of the thigh permit the entrance of air about the
socket, and at the same time rupture the ligamentum teres. The dis-
articulation is thus readily effected. Try to sever all known anatomical
arteries before loosening the elastic constriction. In this, as in other
amputations through thick muscular areas where small retracted arterial
branches are likely to give trouble in finding them, after securing the
main branches, such as the two femoral, circumflexes, and sciatics, it will
be an expeditious plan to pass deep catgut sutures through the great
masses of muscle all the way up across the cut surface, and to tie these
firmly. In this way dead spaces are obliterated, the muscles are brought
together, and compression exercised, which prevents bleeding.

In some extremely weak cases in which shock is to be feared it may be safer to
amputate the soft parts, secure the vessels, and saw through the bone, leaving the
femoral head in the socket and the wound open and covered with an antiseptic or

aseptic dressing. After the patient has fully recovered the enucleation of the bone can be safely effected. If in spite of ligatures and deep catgut sutures the oozing is considerable, the wound can be tamponed with a dry iodoform pack, over which the flaps are temporarily sutured with a view of securing firm pressure.

At least forty-five other methods of disarticulating the hip could be described, but of all these we prefer to limit our selection to the preceding method, which is a composite of several of the older and best procedures, and because in its perfect hæmostasis it exhibits the latest and most practical phase in the evolution of this once formidable operation.

Causes of Death and Comparative Mortality after Amputations.

The immediate causes of death are—(1) *hemorrhage ;* (2) *shock ;* (3) *exhaustion ;* (4) *air- or fat-embolism ;* (5) *accidental complications* from the toxic effect of anæsthetics or pre-existing diseases.

The secondary causes of mortality are the various *infections ; osteomyelitis ; gangrene* from atheroma or diabetes ; *secondary hemorrhage.*

In considering the general mortality of amputations a comparison between the preantiseptic and the modern aseptic period will be instructive. Legouest, whose statistics were based upon the military experience of the Crimea, arrived at the following results: Fingers and metacarpals, 13 per cent. ; toes, 18.9 ; tibiotarsal disarticulations, 23.2 ; metatarsal and partial foot amputations, 38 ; leg, 49.9 ; thigh, 74 ; disarticulation of knee, 87 ; hip-joint, 87.7 ; wrist, 35 ; forearm, 41.1 ; arm, 47.7 ; elbow, 48 ; shoulder, 59.5.

Operations on the upper are less fatal than those at corresponding points on the lower extremities, because (1) they are smaller in size ; (2) they are nearer the centre of the circulation ; and (3) they are less likely to suffer from septic infection (anus, genitals).

The mortality of the modern period as exhibited in American practice is well shown by Dr. J. F. Erdman in his statistical report of 703 major amputations from the records of eight leading hospitals of New York City.[1] In ten years there were 703 single amputations, with 109 deaths, or 15.5 per cent. mortality, irrespective of cause (injury or disease).

By subdividing the whole group into sections Erdman's statistics yield the following results :

Wrist . . . . . . 1. per cent.	Foot . . . . . · · · 7.8 per cent.
Forearm . . . . 1.4 "	Leg . . . . 12. "
Elbow . . . . . 0. "	Knee . . . . . . 13. "
Arm . . . . . . 18. "	Thigh . . . . . . 21.5 "
Shoulder . . . . 25. "	Hip . . . . 34.4 "

The mortality of the hip amputations is certainly here in excess of the results obtained by Wyeth's method, as estimated by this author from the cases reported by various operators.[2]

The most favorable results have been obtained by an American operator, W. L. Estes of Pennsylvania, who reports 294 single amputations, performed by himself, chiefly for traumatism, with a mortality-rate of but 4.6 per cent. The same surgeon reports 51 double synchronous major amputations, and 9 deaths, or a general mortality-rate of 17.66 per cent. This is a remarkably good result, considering that the mortality until quite recently was enormous (44. per cent. in some of the best-equipped modern clinics ; Schede).

[1] *Vide Annals of Surgery,* pp. 358–362, vol. xxii., 1895.
[2] *Proceed. N. Y. State Med. Asso'n,* Oct., 1893.

THE STUMP.

After the saving of life and the removal of the offending part, the object of every amputation is to provide a healthy stump that will render the greatest possible service to the bearer in after life.

A **good stump** is characterized by its *regular outline*, its *firmness, solidity, mobility, painlessness*, and *capacity for resisting friction and pressure at exposed parts*. The bone should be amply covered, and the skin covering it should not be adherent to its surface; the scar should be linear if possible, and completely hidden in a narrow groove in the most inactive surface. In shape, especially in the lower extremity, it should be like a gradually decreasing cone with a well-rounded outline and free from uneven surfaces. For prosthetic purposes it must be of sufficient length to provide leverage with which to swing an artificial limb, and possess the firmness to bear the contact with the socket, that both the natural and artificial socket may now move and be operated as one (Truax).

The **bad stump** is characterized by a deficiency in the preceding qualities, and is usually associated with either one of the following conditions: viz. conicity (pathological or physiological), ulceration of the

FIG. 276.   FIG. 277.
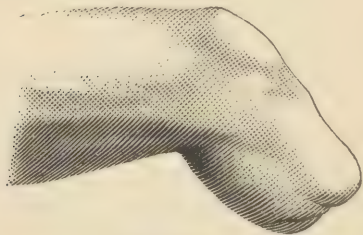
Ideal stump.
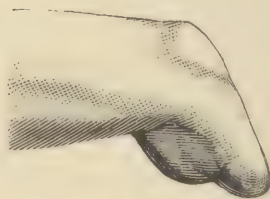
Bad stump, because posterior flap was cut too short, and there has been great retraction of all soft tissues (Farabeuf).

skin and other soft parts, necrosis of the bone, neuralgia. A bad stump may owe its evil properties to many conditions which are not necessarily associated with the method adopted during the amputation. An amputation wound is liable to all the ills and misfortunes which may attend the course of any other traumatism. Thus sloughing of the skin, with excessive retraction of the soft parts, may be caused by defective nutrition of the extremity from constitutional conditions or pre-existing visceral lesions which interfere with the venous return or diminish the arterial supply (senile atheroma); from defective innervation, peripheral or central trophic lesions of the nervous system; certain infections— viz. erysipelas, malignant œdema, also diabetes. After the stump heals a large weak scar-surface remains, which usually becomes painful and eczematous with the least provocation. Corns may also develop over exposed friction-points, or adventitious bursæ may form which inflame easily and help to make the artificial limb intolerable. If the flap-covering is sufficient, the soft parts may retract to such an extent that the bone will project naked at the end or be merely covered with scar-tissue: this is the typical pathological conical stump. If the bone

becomes infected, osteomyelitis and necrosis will follow. The rough or too rapid use of the saw during the amputation is not a rare cause of necrosis of the bone, which frequently necessitates reamputation.

A secondary conicity of stumps is not rarely observed after amputations in children, due to the physiological growth of bone during development. This is also a not infrequent cause of reamputation, and must be borne in mind in pediatric practice. The stump may present a healthy appearance in every respect, and yet it may be very painful (the neuralgic stump), and thus be more than useless to its possessor. This neuralgic condition may be due to adhesion of nerves to the scar or pressure on these parts at friction-points, and is usually associated with bulbous enlargement or neuromatous tumors of the divided nerve-trunks. This is also largely due to the neglect of the precaution previously urged—*i. e.* to cut the nerves high above the original lines of amputation, so that they may be protected and prevented from contracting adhesion to the scar.

The Care of the Stump after Healing, Preparatory to the Use of an Artificial Limb.—The tendency of stumps, especially those of the lower extremities, is to remain a long time enlarged and flaccid. Whenever the amputated extremity is allowed to hang in a dependent position it becomes œdematous and cyanotic from vasomotor paresis. In time, if not treated actively, it also develops a tendency to accumulate fat, which makes it so unwieldy and thick at its terminus that it interferes with the proper adjustment of the conical socket of the artificial limb. In amputations of the leg below the knee the stump will have a tendency to become flexed and the knee stiffened and ankylosed in consequence of the unbalanced traction of the powerful flexor muscles. The adjustment of an appropriate splint during the healing process, the frequent bathing of the limb with hot water and alcohol, daily movements of the joint, systematic massage, and, finally, the application of a firm roller bandage from the extremity to the root of the limb, will correct these difficulties and will rapidly prepare the stump for the prosthetic appliance.

How Soon after Amputation should an Artificial Limb be Applied?—The time is variable and depends upon a multitude of conditions. The average period is three months (Agnew), but the safest rule is to allow just as long a time to elapse as is necessary for the thorough healing of the stump, *and no longer* (Cook). If too much time be allowed to elapse after the healing of the stump, the muscles become atrophied and inert, the joints stiffen, and a much longer practice is required of the patient to acquire the necessary mastery of the artificial substitute for the lost part.

CHAPTER XVI.

ORTHOPÆDIC SURGERY.

By ROBERT W. LOVETT, M. D.

TORTICOLLIS.

Torticollis is the name applied to a condition characterized by a deformed position of the head, which is held to one side by a unilateral contraction of the sterno-mastoid and other muscles. This condition is also spoken of as wry-neck and caput obstipum. The affection is either congenital or acquired.

Of the congenital form, (1) a class of cases occur where the condition is undoubtedly due to that obscure cause, call it what we may, which results in club-foot and similar deformities. In these cases the wry-neck is accompanied by other malformations. (2) *Abnormal pressure in the uterus* is undoubtedly the cause of some cases, and is manifested not only by the twisted position of the head, but in an asymmetry of the cranium and face, the side on which the muscles are contracted being the smaller. (3) *Inflammation of the muscle* undoubtedly occurs, as manifested by the pathological data about to be spoken of. (4) *Affections of the nerve-centres* and of the nerves themselves have been alluded to, but the theory rests upon no scientific foundation. (5) *Rupture of the sterno-mastoid muscle,* occurring perhaps at birth, is an undoubted cause of torticollis. Of late attempts have been made to deny the existence of hæmatoma as a cause. A case, however, has been reported by the writer where a child was seen shortly after birth with a tumor in the sterno-mastoid muscle, evidently the result of a tearing of it. This case two years later showed a typical torticollis.

Acquired torticollis results from muscular contraction—(1) *due to exposure to cold,* when it is probably rheumatic in origin ; (2) it results from *unequal sight* in the two eyes, which makes it necessary to hold the head to one side in reading, and which may result in a permanent contraction ; (3) *contraction of the muscles,* and consequently wry-neck, may occur from burns, injuries, or tumors ; (4) it may be the result of a *tonic or clonic muscular spasm* due to some central or peripheral cause affecting the nervous system. It may also result from paralysis.

Both congenital and acquired torticollis occur most often in children.

PATHOLOGY.—The pathology of the affection has been determined by autopsy and by pieces of affected tissue removed during operation. In some instances the muscle appears normal. More often, however, the contractile tissue is replaced by fibrous tissue. This may be in small patches, in which case Volkmann [1] and Vallert [2] have assumed

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[1] *Cent. f. Chir.,* 1885, No. 14.　　　　[2] *Ibid.,* 1890, No. 38.

the existence of a " fibrous myositis," or the whole muscle may be transformed into a tendinous band (Bündell,[1] Hensinger[2]). Shortening of the muscle on the affected side may be several centimetres (Bouvier,[3] Guyon[4]). In a case of congenital torticollis measured by Shaffer[5] when the patient was six years old, and again when sixteen, the length of the muscle was found to be the same at both times. In old cases where the muscular substance has been replaced by fibrous tissue the muscle is adherent to the sheath by many bands, and in some severe cases the two structures become fused and cannot be identified (Duval,[6] Bouvier). The sternal fascia is more often contracted than the clavicular. Asymmetry of the head and lower jaw exists in many cases (Nélaton, Broca, Eulenberg, Witzel[7]). After rectification this becomes more prominent than before. It is said that atrophy of the cerebral hemisphere of the contracted side may accompany the facial and cranial asymmetry (Diffenbach, Greffie,[8] Broca[9]).

Lateral curvature of the spine is apt to result from the abnormal position of the head in long-continued cases. In many cases, in addition to the contraction of the sterno-mastoid muscle, the posterior muscles at the side of the neck, and even the small vertebral muscles, may be affected. In some cases the contraction of these muscles predominates so much that the affection is spoken of as " posterior torticollis."

Secondary bony changes may occur as the result of long continuance of the abnormal position. The clavicles have been found of unequal length and the carotid arteries of different size. Many theories have been advanced to account for the asymmetry of the head and face.[10]

FIG. 278.

Torticollis.

SYMPTOMS.—The one symptom of torticollis is the abnormal position of the head accompanied by the usual muscular contraction. The ear of the affected side is brought nearer to the sternum, the face is rotated to the unaffected side, and the chin is somewhat elevated (Fig. 278). The whole head is generally tilted toward the affected side, but this varies with the degree to which the trapezius muscle is affected. The position of the head will vary in many respects according to the involvement of the different muscles. This position may be spasmodic or constant. If constant, reposition is not possible, and an attempt to rectify the position of the head results in bringing out as tense bands the sterno-

[1] *Vogel's Neue Med. Bibl.*, 1762, v. 189.
[2] *Bericht von. d. Anthrop. Austatt. zu Wurzburg*, 1826, p. 26.
[3] *Leç. clin. sur les Mal. de l'app. loc.*, Paris, 1895, pp. 77 and 85.
[4] *Dict. ency. des Sc. méd.*, 4me Série, xvii. 670.
[5] *Trans. Am. Orth.. Ass'n.*, vol. iv. p. 305.   [6] *Revue des Specialistes*, 1843.
[7] *Deutsch. Z. für Chir.*, xviii. 534.   [8] *Montpel. méd.*, Nov. 16, 1890.
[9] Quoted by Redard.   [10] Young, *Orth. Surgery*, p. 256.

mastoid and other affected muscles on one side. Attempts to correct
the deformity in the congenital form will not be painful, but in the vio-
lent spasmodic form of the affection are generally accompanied by much
pain.

DIAGNOSIS.—Although the diagnosis of torticollis is ordinarily an
easy matter, it is sometimes difficult to differentiate it from cervical
Pott's disease, where a similar wry-neck is not uncommon. In Pott's
disease all the muscles of both sides resist passive movement and attempts
at reposition of the head. Pain is almost sure to be present, very little
movement in any direction is allowed, the temperature is probably ele-
vated, and the other symptoms of tuberculous bone disease are present.
In torticollis, on the other hand, asymmetry of the face is common,
motion is allowed in any direction except where the muscles are con-
tracted, and the contraction of the muscles is always unilateral.

Again, true wry-neck may be simulated by sprains of the neck resulting from
falls, which cause the head to be held stiffly to one side. Rheumatism of the neck,
enlarged and inflamed cervical lymph-nodes, inflammation of the middle ear, and
deep cervical abscess in the same way may cause a position of the head which
simulates that of true torticollis.

PROGNOSIS.—The prognosis in congenital torticollis is not good so
far as spontaneous recovery is concerned. The deformity progressively
increases up to a certain point, when lateral deviation of the spine is apt
to occur. Spasmodic torticollis, on the other hand, may recover spon-
taneously. It may yield to medical treatment, but may persist for years
unaffected even by operative measures.

TREATMENT.—The treatment of congenital torticollis has been
mechanical and *operative*. The treatment by apparatus is unsatisfac-
tory, and for the most part abandoned in modern orthopædic surgery.
Why this is the case is easily understood if one considers the patholog-
ical condition. The older books on orthopædic surgery contain pictures
of an indefinite number of appliances used for this deformity, to which
the interested reader is referred. The writer wishes to advocate only
operative treatment except in the slightest cases, where a tentative effort
at correction may be made by means of massage, head suspension, and
vigorous manipulation. If it is desired to try mechanical treatment,
the apparatus described in connection with the operative treatment is
probably the best to be used.

Division of the contracted sterno-mastoid muscle and other resistant
structures is the modern treatment of torticollis. It may be done sub-
cutaneously or by an open incision. The sternal part of the muscle is
often the only part contracted, but operation almost always shows the
presence of a much deeper contraction than is generally apparent, involv-
ing the clavicular part also. Subcutaneous tenotomy is widely practised,
especially in Europe, but when one considers the position of the internal
jugular vein, which lies so closely under the clavicular portion of the
muscle, most careful surgeons will prefer an open incision as being more
thorough and less dangerous.

This vessel has been divided in both methods of operation. Open incision
exposes the muscle, either by a cut parallel to the clavicle and one inch above it,
or by an incision along the anterior border of the muscle, which leaves a less
noticeable scar. The internal jugular vein is likely to be exposed in thorough
operations. In intermittent torticollis division of the muscle is of little use, and

stretching, division, or resection of the *spinal accessory nerve* must be resorted to if electricity and mechanical treatment have failed.

After division of the nerve relief is generally not immediate, but spasms persist for some time. Division of the posterior cervical nerves has been advocated under these circumstances. After operation the head should be maintained in an over-corrected position for two weeks at least. This is accomplished by confining the patient to bed and by applying to the head three strips of adhesive plaster to which weights are attached. By pulling in three different directions these roll the

Fig. 279.   Fig. 280.

Apparatus for torticollis (by permission of the managers of the Children's Hospital, Boston).

head in the opposite position from that of the deformity. Maintenance of the head in a slightly over-corrected position is necessary for some months after operation in severe cases. This is most easily accomplished by the use of the apparatus devised by Dr. Buckminster Brown (Figs. 279 and 280), which is simple and efficient. It is shown in the figures. A Taylor back-brace with a head-support connected by ball-and-socket joint to the brace is the best of the appliances to be obtained of the instrument-makers, or a plaster-of-Paris bandage may be applied to the head and neck.

LATERAL CURVATURE OF THE SPINE (SCOLIOSIS).

Lateral curvature of the spine, or scoliosis, is a deformity characterized by a lateral deviation of part of the spinal column. This causes a change and inequality in the contour of the body. In all but the mildest cases the lateral deviation of the spine is accompanied by a rotation of the vertebral column on a vertical axis. Under these circumstances the name *rotary lateral curvature* is applied to the condition.

Although scoliosis may rarely exist as a congenital affection, it is then a deformity due to intra-uterine rickets or to imperfect development of one half of the body. It was formerly thought that lateral curvature developed at the time of

puberty, but later researches have shown that it occurs earlier in most cases. In 1000 cases collected by Eulenberg, 85.8 per cent. showed the development of the deformity before the tenth year. Girls are, for some unexplained reason, affected much more frequently than boys. In 2509 cases collected from various authors by Young, 2123 were girls and only 386 were boys. The deformity is much less frequent in America than in Europe as a rule, and, although some slight degree of lateral inequality is exceedingly common in our streets, severe cases are not often seen.

The ETIOLOGY of scoliosis may be formulated simply as follows: In general, the muscular development of these patients is below the average and the circulation is less vigorous than it should be. The digestion is often poor and the children are most often poorly nourished. Ocular defects may be present. These conditions may be spoken of as *predisposing causes*. In considering the *immediate causes* of the deformity in certain cases it is plainly evident what the causation was, but in the majority of cases this immediate cause lies hidden in the deepest obscurity, and, although many fanciful theories have been adduced to account for it, it certainly seems more scientific to admit that in the majority of cases of scoliosis we cannot speak definitely as to the immediate cause. Among the cases where the causation is plain may be mentioned those resulting from (*a*) *empyema,* (*b*) *infantile paralysis,* (*c*) *cerebral paralysis,* (*d*) *hereditary locomotor ataxia and pseudo-hypertrophic paralysis,* (*e*) *rickets,* (*f*) *marked inequality in the length of the legs,* (*g*) *certain occupations necessitating the use of one arm,* (*h*) *the loss of one arm and similar changes,* (*i*) *torticollis.* The remainder of the cases cannot be accounted for in any such obvious way, and certain theories have been advanced to account for their origin. These are as follows: (1) that *unequal muscular action* or that a unilateral muscular contraction causes the deformity: evidence is wanting to show primary weakness of the muscles; (2) that the affection is due to *unequal bony growth* of the two sides; (3) that the superincumbent weight of the body comes upon the spinal column held in a faulty position.

In some experiments on the cadaver undertaken by Bradford it was demonstrated that when downward pressure was exerted upon the spinal column held in an oblique position a lateral bending took place when a certain point was reached, which reproduced the features of a true scoliosis. The more obliquely the weight came upon the column, the more marked was the scoliosis. It is in this way that faulty attitudes may cause lateral curvature.

Each one of these theories accounts, of course, for certain cases, but it must be evident that no one is worthy of general application.

The PATHOLOGY throws no light upon the causation of the affection, and only serves to accentuate the importance of early and vigorous treatment. In the early stages of the affection no pathological changes are noticed, and in the later stages the pathological changes are such as result from the prolonged maintenance of a vicious position. The effects of pressure are noticed in the atrophy of the parts of the vertebræ in the concavity of the curve, resulting sometimes in a change from the normal shape of the vertebræ to that of a wedge. The vertebræ are rotated on a vertical axis, and the atrophy from pressure results in locking the column in its twisted and distorted position. The muscles and ligaments are contracted on the concave side and stretched on the convex side. The intervertebral disks atrophy from pressure on the concavity, and the ribs are separated on the convex side and crowded

together on the concave side. They may be so depressed as to reach or even lie inside of the crest of the ilium. The chest is distorted and compressed on the convex side, and the abdominal organs may be displaced downward.

SYMPTOMS.—Much obscurity has been added to that naturally surrounding the study of lateral curvature by the introduction of various terms and subdivisions into varieties and into single and double curves, etc. The condition in question is really this: A persistent lateral deviation of the spine may occur in any part of the dorsal or lumbar region. The convexity of this curve may be to the right or to the left, and it may involve only a few or it may involve many vertebræ. When once a curve in the spine has occurred, it is easy to see that either the person must lean over to one side or that the vertebræ above or below the curve must make a compensatory bend in the opposite direction, by which the general upright position of the body may be maintained. This happens instinctively, and with the dorsal curve to the right one finds a lumbar curve to the left, and probably a cervical curve also. The original curve is at the root of the mischief, and is spoken of as the *primary curve.* The others, which are only incidental, although necessary for equilibrium, are called *secondary* or *compensatory curves.*

FIG. 281.

For some unknown mechanical reason, when the lateral curve has reached a certain degree, which varies in different individuals, the vertebral column begins to rotate on a vertical axis, carrying with it, of course, the ribs. The thorax no longer lies in the same lateral plane as the pelvis. So much has been written to account for this rotation, all of which is unsatisfactory, that the references only are given.[1]

The rotation of the vertebral *bodies is toward the convexity* of the curve; that is, in a right dorsal curve—the angles of the ribs are carried backward on the right side, while the left side of the chest becomes more prominent in front. The most common form of lateral curvature is where the dorsal spine curves to the right (Fig. 281).

Right dorsal curvature associated with talipes equinus of left foot.

The lateral deviation of the spine itself is rarely noticed by the parents, but rather some of the changes are seen which it occasions in the contour of the body. Round shoulders are in many instances, especially where weakness of the muscles is present, the first indication of beginning trouble. The flexion of the spine, however, is rarely appreciated in its true significance, and many a case of serious scoliosis might be prevented if every case of round shoulders were investigated as to the presence of beginning lateral deformity. Most often scoliosis is discovered by one of the following signs: The prominence of one hip; the elevation of one

[1] A. B. Judson, *N. Y. Record,* Sept. 30, 1882; Jan. 19, 1884; Nov. 1, 1890.

shoulder; the backward projection of one shoulder-blade; the greater prominence of one clavicle; the fact that the skirt of the dress hangs unequally on the two sides; the difficulty in fitting the waist of a tight dress on account of the greater distance from the armhole to the waist on one side. It is these trifling and apparently irrelevant signs that most often lead to an examination of the child. The dressmaker is in very many cases the first person to call attention to the condition.

The mobility of the spinal column is not at first affected, but later stiffness of the affected portion generally occurs. Hence comes a very practical division of scoliosis into three grades: (1) lateral deviation with no perceptible rotation on a vertical axis; (2) lateral deviation with rotation, but with no perceptible stiffness of the spine; (3) lateral deviation with rotation and stiffness. Subjectively, the patient rarely notices the condition. Pain is present only as a coincident neuralgia or as the result of muscular fatigue. Dyspnœa may occur in severe cases as the result of diminished chest-capacity. Limping at times may be present in the severest cases on account of the drawing up of the pelvis on one side by the extreme spinal curve. The condition is, in short, a lateral deviation of some part of the spine, not the result of any disease of the bone, but apparently induced by some inequality in muscular force and the distribution of superincumbent weight.

DIAGNOSIS.—From what has been said, it will be seen that the diagnosis of scoliosis in slight cases is more likely to be made from the effects of the curvature than from the curvature itself. The existence of *round shoulders* is always suspicious. For examination the patient, if a child, should be stripped to the hips and examined from in front and behind. Older girls should be covered in front by a common apron tied by strings around the neck and allowed to fall over the chest and abdomen. Examined from in front, especially at a little distance, it will be seen, even in slight cases, that one arm hangs farther out from the side of the body than the other; that the side of the body is more hollow above one ilium than above the other, which gives the appearance of the greater prominence of one hip; that the shoulders are not on the same level; and that in certain cases a lateral deviation of the whole trunk is noticed. The nipples may be noticed to be not in the same horizontal plane. In severe cases these signs will be more prominent, and one side of the chest will be seen to stand farther forward than the other; often it will be seen to be only a one-sided pigeon breast; again, one half of the thorax will be decidedly prominent. In severe cases the unequal prominence of the clavicles will be well marked. In slight cases lateral deviation of the spine is more readily detected from the front than from the back. When examined from behind, the spine can be made red by drawing two fingers along the spinous processes, when a red streak will show plainly the lateral deviation. In slight cases one notices the unequal outline of the two sides of the body, but less distinctly than from in front. The angles of the scapulæ are seen to be on different levels, and the inclination of the whole trunk may again be evident here. In severe cases rotation is noticed by the greater prominence of one scapula, or, if the curve is a lumbar one, by the prominence of the lumbar transverse processes on the convex side of the curve (Fig. 283). The presence of rotation should be searched for by directing the patient to bend forward as if making a bow while the knees are kept stiff and the arms allowed to hang. When the vertebral column becomes horizontal in this position, if one glances from

behind the slightest rotation of the vertebræ can be detected by a prominence of one side of the spine in the dorsal or lumbar region. Where the rotation has occurred in a right dorsal curve, in this position an elevation on the right side of the vertebral column can be noticed if any backward rotation is present (Fig. 283).

By following in detail the methods described above no case of lateral curvature need escape detection.

The flexibility of the spine is tested by allowing the patient to hang from a bar or by manual attempts at reposition. Recumbency on the face will obliterate

Fig. 282.   Fig. 283.

Photograph of case of left dorsal scoliosis.

Characteristic appearance of scoliosis in the stooping posture.

the curve at an early stage. The length of the legs should be measured to see that the curve is not the result of some inequality.

Scoliosis resembles at times the lateral deviation of the spine which occurs in Pott's disease. The absence of the symptoms of Pott's disease, accompanied by the characteristics of the curvature described above, will be sufficient for its detection.

Many complicated and ingenious machines have been devised to record cases of scoliosis, but photography is, on the whole, the most satisfactory method. The photographs are more serviceable if the patient stands in front of a screen on which squares are marked out by black threads (Fig. 284).

The PROGNOSIS in scoliosis is one of the most unsatisfactory parts of the study of the condition. In a given case it is exceedingly difficult for even the most experienced to predict whether or not further deform-

ity will occur. Spontaneous recovery seems to occur at any stage in every variety of case. The spontaneous cure of the deformity, when once it has become enough, for example, to be plainly evident through the clothes, is extremely unlikely to occur. For mechanical reasons it is obvious that it is likely to grow worse.

Fig. 284.
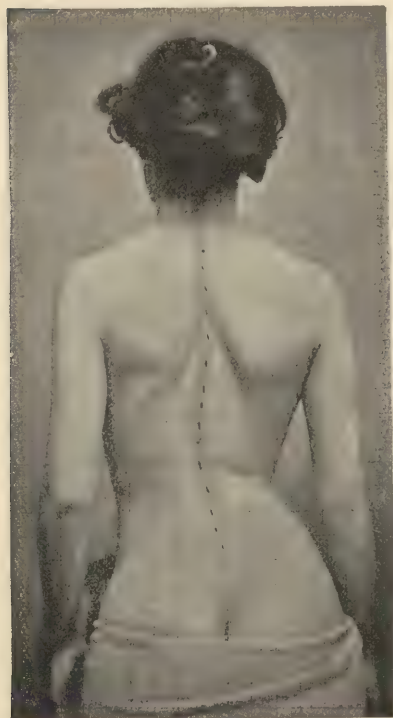
Left lumbar curvature (by permission of the managers of the Children's Hospital, Boston).

Under favoring conditions and long-continued treatment cases of the first grade should be cured; cases of the second grade should be much bettered as to the lateral deviation; and probably cases with slight rotation should improve. The writer is skeptical whether it ever entirely disappears when once it has reached any marked degree. Cases of the third degree can be improved in the matter of lateral curvature, and can be made taller and more comfortable even in neglected cases treated in adult life. For example, a woman of thirty years with a most unsightly curve of fifteen years' standing increased two inches in height during one year's treatment. Improvement is retarded, and treatment even in mild cases must cover six months or a year, and in severe cases from one to three or more years. Relapses are common when treatment is irregular or if it is stopped too soon.

TREATMENT.—There is little agreement among surgeons as to the best treatment of lateral curvature. At best it is slow and uninteresting, and if the attendance is irregular or if the methods are incomplete, progress is unsatisfactory.

The conditions to be met are these : The spinal column is curved to one side ; the superincumbent weight tends to increase this curvature ; rotation on a vertical axis may be present, and stiffness is sure to intervene in time if the vicious position is maintained. The problem of treatment is to straighten this column and to hold it in the correct position. *If stiffness be present, flexibility must be restored*—(*a*) by braces, (*b*) by manipulation and apparatus. *After flexibility has been restored so far as possible, or if stiffness be not present, the column must be held in the correct position* (2*a*) by braces and (2*b*) by the muscles. It is hoped that this statement of an almost self-evident problem may relieve the subject of much needless obscurity.

(*a*) **Attempts to straighten a stiff curvature by means of braces** *are for the most part at present confined to the instrument-shops.* Enormously clumsy and heavy appliances with screws and pads and springs have been much used, and can be found figured in any orthopædic treatise. They need not be discussed here, for they are mechanically inefficient. It is plain that a curved spinal column where rigidity is present cannot be straightened by an apparatus which obtains so little

hold as these, or which works at such a great disadvantage in the matter of pressure.

The *plaster jacket*, or Lorenz's modification of it as a plaster girdle, may be applied with benefit for a few days at a time to severe cases. The curve is corrected as much as possible by bending to one side or by suspension with lateral traction to pull the column as straight as possible. In the corrected position a plaster jacket or girdle is applied and allowed to harden. Repetition of this process for several times, with intervals of three to six days, will often produce much improvement in a bad curve for the time being, but the improvement must be held by other means and the process is most uncomfortable.

(*b*) **Attempts to Straighten a Stiff Column by Manipulation and Apparatus.**—The object of these attempts is by pressure against the convexity of the curve, either intermittent or continuous, to stretch contracted ligaments, fasciæ, and muscles. It does not matter whether the force applied is manual or instrumental. Where stiffness is slight, self-suspension by a Sayre head-piece should be practised, perhaps daily, or the patient might hang from a bar by both arms, and in all but the slightest cases some one should press from the side against the convex side of the curve.

The gymnastic exercises to be described later will restore flexibility in the milder cases. These are, in general, such exercises as tend to throw the body into a position which diminishes the curve. Severe cases need more forcible measures. In a right dorsal curve, for example, a manipulation much used by Dr. Shaffer is very useful. The patient sits on a stool in front of the surgeon between his

<div align="center">Fig. 285.</div>

Self-correction apparatus for lateral curvature (Bradford).

knees, with her back toward him. The surgeon, sitting on a similar stool, leans his right elbow on his right knee and places his right hand, opened flat, opposite the convexity of the patient's curve. He raises his left arm and places his left hand on the root of the patient's neck at the left side. With a slight rotary and shifting motion of the left arm he throws the patient over to the right, so that her

weight comes upon his right arm and knee. This should be repeated several times with as much force as the surgeon thinks best.

Perhaps the simplest form of mechanical apparatus for restoring flexibility is the one described by Bradford (Figs. 285, 286), where *self-suspension* is combined with lateral pressure by means of traction bands. A more forcible machine for applying pressure by screws is shown in Fig. 287. These are used as often as necessary, and if possible the curve is over-corrected. The application of such force is not painful. It may be said, again, that the object of such manipulation is to overcome any stiffness of the spinal column, so that whatever treatment is applied may be to a flexible column.

(2*a*) **Attempts to hold a Flexible Column Straight by Braces.**—Where stiffness has not begun or where it has been overcome the problem of holding the column straight is the one upon which the cure or

FIG. 286.

Self-correction apparatus for lateral curvature (Bradford).

improvement of the case depends. In former years the whole treatment of lateral curvature has revolved around the question of, What brace does this most efficiently? It is more pertinent to ask (and this question is being asked), Is it better to use a brace or to educate the muscles on one side of the column to serve as a support? Any appliance which takes the place of the muscles anywhere in the body, and prevents their use, unquestionably weakens those muscles. This is the chief objection to the routine use of braces in lateral curvature. Again, any appliance which attempts to hold straight a spinal column by a hold upon the pelvis and the movable thorax, while the force of gravity works all the while against it, is necessarily at a great mechanical disadvantage. Other things being equal, it is plain that the best results would come from the education of faulty muscles rather than by supplementing them by

apparatus. Whether or not this can be done is largely a matter of individual opinion. The writer believes that the rational method of obtaining improvement, and cure where possible, in lateral curvature lies in the education of those muscles which tend to overcome the spinal curve.

It is obvious that these muscles cannot be developed immediately to their full capacity—indeed, that their development is a very slow matter—and the question arises whether it is better in the early stages of treatment, after having restored as much flexibility as possible to the column, to hold it in its improved position by means of braces while muscular development is going on, or to depend entirely upon the muscular education for this correction. This must be determined by the muscular strength and the effect which such treatment has upon the position. Where the corrective effect of the exercises is felt for some time, it is safe to allow the patient to go without a brace; but where the muscles are obviously weak and the effect of such exercise is soon lost, it is manifestly better to use some sort of a supporting apparatus between the exercises. In most cases the writer finds it possible not to use braces at all, restricting their use to those cases where the muscles are exceptionally weak, where growth is rapid, where the deform-

FIG. 287.
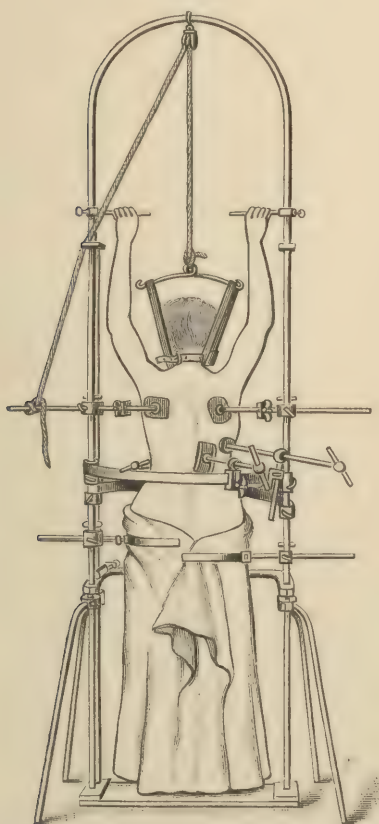
Patient in position in correcting apparatus (Bradford and Brackett).

FIG. 288.

Supporting jacket cut and laced for removal (by permission of the managers of the Children's Hospital, Boston).

ity is extreme, or where it is impossible to obtain frequent gymnastic exercises. Some surgeons, however, believe in the routine use of braces:

(1) The plaster-of-Paris or leather or paper jacket applied during suspension, and cut and laced to permit its removal *for daily muscular exercise* (Fig. 288).

(2) The brace of Dr. Shaffer, which aims at correction of the rotation as well as of the lateral curvature (Fig. 289).

(3) The brace of Dr. Taylor (Fig. 290).

The two latter are difficult to fit and require the services of an expert instrument-maker.

Almost numberless braces are figured in every orthopædic Surgery. For the most part, they are of little or no value, and to works of former years the reader is referred should he desire to know more about the treatment by braces.[1] In

FIG. 289.

Shaffer spine-brace applied to case of left dorsal scoliosis (Young).

FIG. 290.
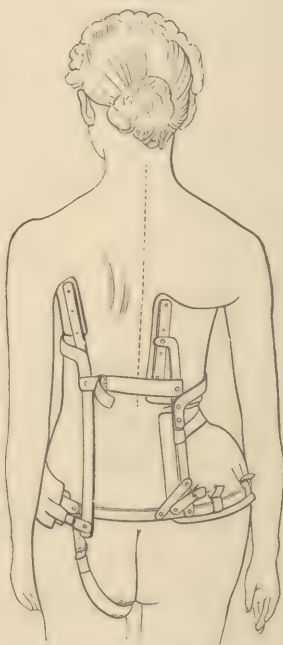
Taylor's brace : right dorsal curvature.

general, except in cases where heart or lung disease is present or in very exceptionally weak persons, braces should only be used in connection with manipulation and exercises.

(2b) Attempts to hold a Flexible Column Straight by Muscles.—When the column has been made flexible or has never been stiff, the development of the muscles on the convex side of the curve is, in general, as has been said, the most rational corrective measure.

If the ends of a flexible rod, *a b*, have been connected by two elastic bands, *c d*, and if one (*d*) were twice as strong as the one on the other side (*c*), the rod would bend with the convexity toward *c*. The easiest way to correct this would be to replace *c* by a band as strong as *d*, in which case the rod would become straight again ; that is, to strengthen the traction force on the convex side of the curve is to work toward the obliteration of the curve. This demonstration, which any one may make for himself, makes it unnecessary to discuss whether the muscles on the convex or concave side of the curve should be attacked. The spinal column is not a rod flexible in one plane, but the conditions of the experiment are to a certain extent applicable. Assuming, then, that the muscles of the convexity should be developed, the general muscular development must also be regarded, especially in connection with the extensor muscles of the back. The chest should

[1] Taylor, *Am. Orth. Assn. Trans.* vol. iii. p. 143, Fig. 6.

be expanded, the abdominal muscles strengthened, and, as far as possible, a correct carriage should be taught. The Swedish system of Ling excels in its ability to isolate certain groups of muscles from work and other groups of muscles for work. It matters little what system the surgeon uses, as long as he is able to pick out a certain group of muscles to exercise. Certain exercises should be general; certain others should be distinctly unilateral.

Fig. 291.

If gymnastic exercises are able to do good, they must be equally powerful for harm. Consequently, accuracy is essential. It is not intended here, nor would it be possible, to give any one scheme of exercises suitable for the treatment of lateral curvature. Each case must be treated upon its individual merits, and the exercises must be adapted to the location of the curve. A position is assumed which by contraction or by relaxation of certain groups of muscles, which it is not desired to exercise, isolates them from further work. Then a unilateral movement is taken which shall exercise a certain group of muscles as often as the movement is repeated.

As an example of this, we will take the following: Technically, it is known as hands, neck, rest, left foot, walk, standing position, trunk-turning, and bending to

High degree of rotary-lateral curvature.

right. In the primary position, before bending is begun, the left lumbar muscles are made to contract on account of the position of the left leg. The right lumbar muscles are relaxed by the hyperextended position of the right leg. The hands at the neck hold the neck muscles along with the arm muscles in a condition of contraction, which prevents them from doing further work; they are thus isolated by being in contraction. By bending and turning the trunk to the right several times the right dorsal muscles are alone active and contract strongly. This exercise is suitable for some cases of right dorsal curvature, inasmuch as it contracts the muscles of the convexity of a dorsal curve. Incidentally the left lumbar muscles are also contracted.

Another exercise is known as the stretch stride standing, trunk bending to left side. The separation of the legs holds the pelvis square. The arms being extended upward above the head, isolate from further work the arm, scapular, and upper dorsal muscles by placing them in contraction. A bending to the left, made either with or without resistance, is accomplished entirely by the left lumbar muscles. Such an exercise serves as an instance of isolation of muscles for exercise in a case of left lumbar curvature.

The exercise for the isolation of the erector spinæ muscles is known as the neck, rest, prone, sitting extension of trunk with resistance on lumbar region. The scapular and upper dorsal muscles are isolated by the position of the arms, which are held behind the head. The leg muscles are isolated from work by the sitting position, and the straightening of the body against resistance is accomplished almost entirely by the erector spinæ muscles.

These exercises, selected at random, serve to illustrate the exactness and the reasonableness of the Swedish system of gymnastics. In itself it has no place for forcible correction, which to the writer's mind in

severe cases is a necessary part of any successful system of treatment. In so far as treatment by muscular education goes, it may be said that the principle is simply the systematic and continual exercise of the muscles on the convex side of the curve, taken in connection with a certain amount of developmental general exercise, and in connection, if need be, with forcible correction to restore flexibility to the stiffened column. In a general way, the contraction of muscles on the convex side of the curves will throw the body into a corrected position, spoken of by Roth as the "keynote" position.

Massage to the weaker muscles is an adjuvant to the treatment.

Cases should be treated as often as possible—once or twice a day if feasible, three times a week at least. The more frequent the exercises the better the results. After treatment the patient should lie still at least one hour. Relapses are not infrequent where treatment is discontinued too soon. It is not likely that the maximum of improvement will be reached even in a slight case in less than six months of active treatment and six months of a continuation of exercises. Electricity may be of some use, but it is only a detail of treatment.

The writer has passed by without mention the great majority of appliances and measures in use in former years and to a certain extent still in use to-day. This has not been done carelessly, but simply to strip the treatment of all unnecessary detail and to present only what seemed essential. It may be repeated that the treatment, in a word, consists in rendering a stiff column flexible and educating the muscles to hold the column in an approximately proper position. As an adjunct to this treatment the use of braces may be necessary.

Congenital Dislocation of the Hip.

This is an affection of considerable rarity, which may occur alone or in connection with other deformities, such as club-foot, hare-lip, and the like. It is by far the most common of the congenital dislocations and may affect one or both hips.

Dislocation of one hip is twice as common as double dislocation, and for some unexplained reason girls are affected much more frequently than boys; of 341 cases collected by the writer, 301 were girls. Lorenz,[1] in 671 cases analyzed, found 87.8 per cent. of girls among those affected. There were among these 245 double dislocations and 421 single dislocations.

As to the causes of this deformity, there has been much speculation. Certain cases are undoubtedly caused by injury at birth, and although these cannot properly be classed as congenital dislocations, yet they resemble them so closely that they are not recognized separately. Other cases are undoubtedly dislocated by traumatism during intra-uterine life, but the majority of cases must be accounted for, as are other congenital deformities, by an arrest of development of the acetabulum. The Y cartilage at the bottom of the socket fails to carry on the growth of the three segments which form the acetabulum.[2] The head of the femur in these cases may reach the normal size, and the stunted acetabulum is not large enough to hold it in place. In other cases, and more often, the head of the femur is small and imperfect; it may be entirely wanting, and intermediate conditions are present. In the great majority of cases the head of the femur is found to rest upon the dorsum of the ilium, either upon the bone itself or upon the gluteus minimus muscle. The acetabulum in general is smaller and shallower than normal, and seems to be filled with fat, connective tissue, and cartilaginous substance which can be scraped away with a curette. The capsule of the joint—upon which,

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[1] Lorenz, *Path. und Ther. der Aug. Huftverrenkung*, 1895.
[2] Grawitz, *Virch. Arch.*, 1878, lxxiv. p. 1.

of course, the chief part of the body-weight rests in walking—is much hypertrophied, thickened, and stretched. Where the congenital dislocation is of long standing the part of the capsule which lies between the head of the femur and the new socket may be worn away, and the capsule appears in this case to be attached to the rim of the new acetabulum. In short, the capsule with the pelvi-trochanteric muscles has become only a tough suspensory ligament. The pelvi-trochanteric muscles are all stretched. If the new acetabulum forms directly over the old one, the pelvis remains in practically the normal plane, and but little lordosis is present; if, however, the new socket develops posteriorly, the pelvis tilts and marked lordosis results. The upper part of the pelvis is constricted and the lower part elongated in later life. The ligamentum teres may be normal, but is most often wanting or subject to various irregularities.

SYMPTOMS.—Children with double dislocation (Fig. 292) are, as a rule, late in walking, and when they do, they show a rolling gait and an

FIG. 292.
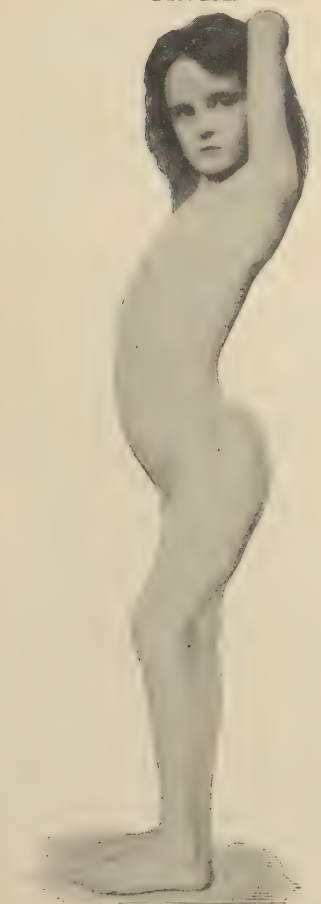
FIG. 293.

Double congenital dislocation of the left side.

Unilateral congenital dislocation of the left hip, showing the natural position in standing (Lovett). (By permission of the Trustees of the Fiske Prize Fund.)

exaggerated swaying of the body from side to side which resembles the gait of extreme bow-legs. The trochanters form a well-marked prom-

inence posteriorly, and the view of the back of the child shows a bow-
ing forward of the lumbar spine, which is all the more striking on
account of the projection of the trochanters through the glutei muscles.
The legs are farther apart than they should be normally when viewed
from in front, and the perineum is unduly broad.   The children rarely
complain of pain and are well developed in other respects.   When
single deformity is present, the child limps distressingly on the affected
side at each step, and shows a gait which is simulated only by severe
infantile paralysis of one leg.   The affected leg is generally shorter
and smaller than the well one, and on account of the elasticity of the
suspensory ligaments it is impossible to correct the limp entirely by a
high sole on the short side.

DIAGNOSIS.—The diagnosis is not always easy.   In theory one
should be able to detect dislocation of the hip by drawing Nélaton's
line on the skin and seeing if the trochanter projects above it.   In
young children this is not always an easy matter to do, and the diag-
nosis is sometimes one of much difficulty.   One has to rely on the
shortening, the abnormal mobility of the joint, the presence of a click
as the head slides over the rim of the acetabulum, and in most cases
the elevation of the trochanter.   If the limb be pulled downward with
the hand or forward when flexed to a right angle, it can generally be
felt to yield.   Rotation will often demonstrate the head of the femur
and its approximate size.

The fact that a well-marked click in the hip-joint is present in manipulation
is suspicious, but is not a definite sign.   Rhachitic bending of the neck of the femur
may resemble congenital dislocation, inasmuch as the trochanters lie above Néla-
ton's line, and the gait of those affected is rolling and like that of congenital dis-
location, but the bones forming the hip are firmly in place.
The affection need never be confused with hip disease.

PROGNOSIS.—Without operation there is little prospect of improve-
ment.   Some cases grew worse as puberty is reached, while others
improve somewhat.

TREATMENT.—The earlier methods of treatment by continuous ex-
tension in bed or by means of ambulatory apparatus making traction
have been for the most part abandoned, because not only must the
treatment be very long and irksome, but the results have not been
satisfactory and relapses have been common.   Apparatus may be of
some use.   Lorenz and Hoffa are both advocates of the use of a corset
in cases which cannot be operated upon, especially cases of double dis-
location.   These corsets hold tightly to the pelvis and are padded to hold
down the trochanters.   Improvement, however, may be brought about
by continued traction lasting from two to five years, but few patients
are so situated that they are either willing or able to pursue so long a
treatment.   Traction by heavy weights as a preliminary to operation
in older and more difficult cases is advocated by some writers (Lorenz).
Treatment by traction alone is not to be recommended.

Tenotomy of the peritrochanteric muscles and subcutaneous division of the
fasciæ and muscles, as pursued by Adams and Barwell, have been abandoned.
Excision of the joint has not proved a satisfactory measure for the relief of the
condition.   Of 27 cases analyzed by the writer, 3 could be classed as good results,
5 were moderate results, and 8 were bad results.   As a curative measure ex-
cision of the head of the femur cannot be recommended as a mode of treatment.

The *injection of a 10 per cent. solution of zinc chloride* into the affected hip-joint has been advocated by Lannelongue for the purpose of exciting a bony growth at the seat of the injection. So far as known, the treatment has not been followed out in America.

The method of Paci [1] has attracted considerable attention. The child is etherized, and the movements of reduction of an ordinary traumatic dislocation are made slowly, forcibly, and accurately. First the limb is flexed, then abducted, rotated externally, and extended. After correction a plaster-of-Paris bandage is applied along with traction of 4 to 10 kilogrammes. After some months a corset is applied and the child allowed to go about. The hip is protected thus for nearly a year and a half after operation.

Fig. 294.

Paci reports as operated on by this method 22 cases of single luxation and 2 of double, in all of which he had good results. The author quotes favorable opinions from many surgeons, but the weight of opinion is against the method. Post of Boston many years ago obtained a fair result from a forcible reposition like this, which shows that some cases can be easily corrected. Lorenz speaks of the method as one chiefly useful in the hands of its originator. It has had little use in America.

The **operations** devised by Hoffa and Lorenz have the greatest claim to surgical attention.

Hoffa's operation aims at relieving the contraction of the periarticular soft parts by a free incision of the capsule and peritrochanteric muscles, and at replacing the head of the femur in an artificial socket made by deepening the original acetabulum. Hoffa advocates a posterior incision as if for excision of the hip. The posterior aspect of the joint is exposed; the capsule is opened and extirpated in so far as it offers any resistance to reduction. Any resistant bands which prevent the femur from being pulled down are cut. If necessary the hamstring muscles and adductor tendons may be divided. The

Front view of a double dislocation of moderate severity, showing the characteristic attitude in standing, as well as the broadening of the perineum.

original acetabulum is deepened and widened with a heavy sharp curette. The head of the femur is placed in this socket and the wound is closed.

The operation of Lorenz is simpler, less destructive, and avoids the destruction of the muscles surrounding the hip. He advocates an anterior incision which exposes the joint, and the capsule is opened by a T-shaped incision. The head is made smaller if need be, the acetabulum is scraped out, and reposition is accomplished.

Bradford calls attention to the importance of the division of the Y-ligament. The limb is put up in a position of slight abduction. The operation has been but little done in America by the method of Lorenz. Lorenz himself operates with much rapidity, and the operation only lasts a few minutes. He reports 100 cases

[1] *Revue d' Orthopédie,* Sept., 1894.

without a death operated on by his method.[1] Broca[2] reports 25 cases operated on by Hoffa's method; 5 died (4 of sepsis), there was 1 case of relapse, 1 recovered with ankylosis, but of the cases where the results were obtainable they were excellent; 2 walked without a limp. Of 177 cases by German surgeons, there were 6 deaths, which may have been due directly to the operation, making a mortality of 3.3 per cent. The German surgeons describe a large proportion of cures from their operations. Hoffa's operation is the one which has been done in America, and it must be admitted that American surgeons, as a rule, have not been able to procure such results as are reported in Germany; and it is not an unfair statement to say that, so far as the Hoffa operation is concerned, it is regarded here as being of questionable utility in most cases. With regard to the Lorenz operation, American surgeons have had but little experience with it, and have regarded it chiefly as a modification of the Hoffa technique. It is, however, a very different operation, and it is likely that it will have a more brilliant future than the Hoffa method.

With regard to operation in general, it may be said that the reposition of the head is easy, although it is sometimes hard at first to recognize the original acetabulum. The difficulty comes in retaining the head of the femur in the socket. After any operation the wound should be closed and perfect quiet insisted upon for about four weeks, when passive motion should be begun. It is necessary that the joint should be protected for some months by some splint or appliance which prevents the weight from coming upon the hip-joint. The whole question of operation must at present be considered as being *sub judice*. From the American standpoint the Hoffa operation has been largely a failure. The Lorenz operation has been hardly known, and any operation at present must be regarded to a certain extent as a surgical experiment. Treatment by traction and other methods has not yielded good results, yet untreated cases are likely to grow worse as they grow older. Consequently, a certain number of people prefer to take the chances of an operation which may yield an excellent result or, on the other hand, which may result in failure.

Dislocation of the hip may occur during the acute arthritis of infants from separation of the epiphysis of the femur. In later years this condition may simulate congenital dislocation of the hip most closely. Dislocation of the hip may also occur later after severe infantile paralysis where the muscles become relaxed and allow the head of the femur to slip out of the acetabulum.

The TREATMENT in either of these cases does not differ essentially from that of congenital dislocation.

Coxa Vara.[3]

Coxa vara, or incurvation of the neck of the femur, is an affection to which attention has been directed of late. It is rhachitic in origin, and affects most often adolescents, although it probably is more of a factor in children with rickets than has been supposed.

Pain, limping, shortening of the affected limb, and elevation of the trochanter are all present: eversion of the limb is noted. It is to be distinguished chiefly from congenital dislocation of the hip-joint and from hip disease, which it simulates, by pain and tenderness.

Rest and protection to the joint are followed by good results in the early stages, but osteotomy may be necessary.

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[1] Lorenz, *Angeb. Hüftverrenkungen*, Wien, 1895.   [2] *Revue d'Orthopédie*, Nov. 1, 1895.
[3] *Trans. Am. Orth. Ass'n*, vol. vii. p. 270, and quotations in Tubby's *Orthopædic Surgery*, London, 1896, p. 263. Also recent paper by Alexander Ogston.

Bow-legs.

The condition known as **bow-legs, or genu varum,** is most often the result of rickets and occurs chiefly in young children. Bow-legs may also result from ostitis deformans in elderly people. It is characterized by an outward bowing of the bones of the leg, which at times is associated with or replaced by a forward bending of the tibia and fibula, and one speaks of the latter condition as anterior bow-legs.

Bow-legs occurs for the most part in children between one and four years of age, but as a rule it is not noticed until the children begin to walk. It is not in all cases—perhaps not in most cases—caused, as has been so commonly supposed, by allowing the child to walk too soon, but rather it is the result of a tonic contraction of the muscles which pull the softened bones out of the straight line. The weight of the child in walking when it comes upon the softened bones tends, of course, to increase the curve. Although it is associated in most cases with a certain degree of rickets, bow-legs may be found at times in children where the diagnostic signs of rickets are not present; yet it must be assumed that the softening of the bones has existed if this distortion is to be found. It occurs not infrequently in children under six months of age, and between six months and a year and a half many cases develop. It is a more common deformity than knock-knee. In 9050 cases of surgical disease in children which were analyzed there were 570 cases of bow-legs and only 370 cases of knock-knee. Both knock-knee and bow-legs affect boys more frequently than girls.

The condition of anterior bow-legs is characterized by a bowing forward of the tibia and fibula. This is generally most prominent at the junction of the lower and middle thirds of the leg. It occurs, as a rule,

Fig. 296.

Fig. 295.

Anterior bow-legs.

Bow-legs affecting both tibia and femur.

in the cases were severe rickets is present, and is generally associated with some outward bowing of the leg or with knock-knee.

Symptoms.—Children with bow-legs stand with the feet wide apart, even in the milder cases. In walking they sway from side to side with a rolling gait, balancing themselves over each leg as it rests in turn on the ground. The fact that they stand with the feet apart is probably

due to muscular weakness, and because the centre of support is removed so far outside of the centre of gravity. The bowing is of two types (Figs. 295, 296). In one it affects the femur and the tibia; in the other it affects the latter bone alone. In the former case the children stand forming a well-defined oval with their bowed legs. Where the tibia alone is affected the general symmetry of the curve is less. The easiest method to find out whether the curve involves the femur to any extent is to cross one leg of the child over the other, placing the inner sides of the knees in contact when the child lies down. In cases where the curvature is principally in the tibia the thighs will come closely together. In extreme cases of bow-legs the knee-joint may be involved, but in general this is not a factor to be considered. The bones of children in the active stage of bow-legs are by many thought to possess a certain springiness, which is often demonstrated to students by bending the legs with the hands and watching the bones spring back, when a distinct yielding is felt. It is probable that this is due to the elasticity of the muscles themselves, rather than to any springiness of the bone. The bones of rhachitic children are plastic rather than elastic.

It is important that a record of cases of bow-legs and of knock-knee should be kept for comparison. This is easily done by making the children sit or lie down on a piece of brown paper with the feet together and the toes pointing upward. With a pencil held perpendicularly to the paper the outline of the legs and feet is traced. These tracings can be inked and kept for reference.

DIAGNOSIS.—The diagnosis presents no difficulty, and the only affection which bow-legs resembles is double congenital dislocation of the hip, the gait of which it simulates very closely. It should be mentioned that the two affections may possibly coexist.

PROGNOSIS.—The prognosis of anterior bow-legs is in general poor, unless operation is undertaken. It is not likely that the children will outgrow the deformity, nor is it easy, as a rule, to control it by mechanical treatment. The outward bowing of the leg, ordinary bow-legs, is a more easily remedied affection, and in young children, except in severe cases, the prognosis under mechanical treatment is almost always favorable. Even without treatment certain cases recover and others do not, but which cases are the favorable ones no surgeon can tell in advance. It has been supposed by some writers that in general it is probable that where the curve is gradual and involves both femur and tibia, spontaneous recovery is more likely to occur than when confined to the tibia alone. In some interesting observations made by Whitman, who observed 2000 people walking the streets of Boston, the prevalence of bow-legs in the adult was shown by the fact that he saw 400 of them bow-legged, while 32 had knock-knee. It is quite evident from this that all cases of bow-legs are not outgrown.

TREATMENT.—The treatment may be expectant, mechanical, or operative. It is hard to state definitely where the need of mechanical treatment begins in bow-legs.

Expectant Treatment.—In certain cases it is easy to see that the mechanical conditions are so bad that some support is imperatively necessary, but except in cases where the curvature is quite marked it is safe to allow the child to continue under observation, taking tracings every three months and massaging the legs and treating the general

condition of rickets; but this is only proper where one can depend upon the co-operation of the parents.

Cases where the children "toe in," walk with a rolling gait and stand with the feet wide apart, are not suitable cases for expectant treatment. Massage and manipulation should be performed at home once or twice a day during either the expectant or mechanical treatment. The parents should be instructed to rub the legs and to attempt to bend them into a correct position, not using enough force to make the child cry.

Mechanical treatment is suitable for all children under four years of age; sometimes after this. Although in children it is difficult after the age of four to accomplish much by braces, it must be said that remarkable results can be obtained, even in the case of much older children, by persistent confinement to bed and by the long-continued use of some splint or bandage which tends to pull the knees together. Mechanical treatment is easily applied by a simple steel upright attached to the body which runs to the top of the inside of the thigh and terminates in an arm curving around and upward. To this upright the legs are firmly pulled by means of leather pads, which act upon the most prominent part of the deformity.

Eversion of the feet in walking is secured by the arms in which these braces terminate. By buckling the ends of these arms behind the back the feet can be turned out to any extent. In cases where the curvature is confined entirely to the tibia the braces can be terminated at the knee in a pad. Various forms of elastic spring braces and other forms of steel uprights are used, but the simple one described is in general satisfactory. Improvement should be noticed within a few months after the application of the braces. When mechanical treatment fails operative measures should be adopted.

The mechanical treatment of anterior bow-legs is unsatisfactory.

Operative measures should not be undertaken with children with bow-legs under the age of three years, and preferably not younger than four, as in these cases the bones are not sufficiently hardened. In most cases a simple fracture of the tibia and fibula is sufficient to correct the line of the leg even where a mild curvature of the femur exists.

Osteoclasis and **osteotomy** are the measures adopted for the correction of bow-legs. Osteoclasis may be done by the hands by very strong surgeons, but the fracture is not so accurately located as that done by some apparatus. The osteoclast of Rizzoli consists of a bar and two padded rings sliding upon it. Between the padded rings a padded plate is screwed down, fracturing the bone at the point of application. It is a simple and satisfactory apparatus for the operation. In fracturing a leg the force of the osteoclast should be so adjusted that it will not break off either at the upper or lower epiphyses of the tibiæ, which are not firmly united at so early an age.

FIG. 297.

Apparatus for bow-legs (by permission of the managers of the Children's Hospital, Boston).

With as little manipulation as possible the bone should be set straight and the leg should be done up in a plaster-of-Paris bandage and treated as a simple fracture. The results of osteoclasis, properly done, are almost uniformly satisfactory.

Osteoclasis is suitable for cases of anterior bow-legs of a mild grade in children over four. The bone is broken, as in ordinary bow-legs, at the seat of the greatest curvature, and in many cases the leg can be placed straight so far as the antero-posterior outline is concerned. Division of the tendo Achillis should be done after the bone is broken.

Osteotomy is to be preferred to osteoclasis if the femur be curved, if there be a curvature of the tibia in two planes, if anterior bow-legs be very marked, or if the bones be very hard. Osteotomy consists in chiselling the bone nearly through and completing the fracture manually. Theoretically, it is not a more dangerous operation than osteoclasis, but bad results due to sepsis occur from time to time. In the worst cases it may be desirable to *remove a wedge-shaped piece of bone*. In severe cases of anterior bow-legs the tibia may be divided from behind, and in this way the removal of a wedge is made unnecessary. In such cases the tendo Achillis will probably have to be divided to bring the foot straight. After osteotomy the leg should be dressed antiseptically and treated as a compound fracture.

KNOCK-KNEE.

Knock-knee is a condition represented by an inward prominence of the knee, caused most often by overgrowth of the internal condyle of the femur. This results generally from *rickets*, but inward deformity of the knee may occur after *fractures*, in *tubercular diseases* of the knee, and sometimes in advanced cases of *infantile paralysis* affecting the muscles of the leg. In the latter instance it is generally associated with some flexion of the knee. The common rhachitic form of knock-knee, which will be the only one considered here, occurs most often in children between two and four years old. It is less common than bow-legs. In most cases it is probably caused by the attitude assumed by these children in standing. Inasmuch as their muscles are weak, they support themselves by standing with the legs apart and the feet everted, being the position in which the least muscular activity is required. This brings more weight to bear upon the external than on the internal condyles, and tends to cause the atrophy of the external condyles of the femur and the overgrowth of the internal.[1] Bending of the shaft of the bones above and below the knee-joint may also occur and increase the deformity, but this is less often the case than in bow-legs. Flat-foot in nearly all cases coexists, probably most often as a result of the same cause—muscular weakness. In severe cases, where the feet are widely separated, an inversion of the front part of the feet is noticed as they reach toward the median line for support. In severe cases the tibia and fibula rotate outward in the long axis of the leg.

SYMPTOMS.—Children with knock-knee walk with a peculiar swaying gait. If they were to walk in the ordinary way, with each foot straight ahead, the prominent knees would knock against each other and progress would be impossible. Consequently, they rotate the legs either outward or inward in order to diminish the prominence of the

[1] Arbuthnot Lane, *Guy's Hosp. Rep.*, xxviii.

inner aspect of the knee, and thus "toeing out" or "toeing in" is often the first symptom to call attention to the trouble in the slighter grades. Pain is absent, but children with knock-knee are clumsy and fall easily. On examination one finds that the deformity, however prominent, disappears on flexing the knee. This is because the condition which causes the deformity is the greater length of the internal condyle of the femur. Examination of the lower end of the femur when the leg is flexed shows the prominence very plainly. Laxity of the lateral ligaments is often noticed, as a result of which the deformity is more noticeable when the patient stands and weight comes upon the knees.

DIAGNOSIS.—The diagnosis presents no difficulty in marked cases. In mild cases, where flat-foot is marked, the attention may be given wholly to the latter condition, and the more serious condition of knock-knee may be quite overlooked.

PROGNOSIS.—The prognosis is not so good as in bow-legs. It is unlikely that any marked degree of the deformity can be outgrown. On the contrary, the mechanical conditions are such that the deformity is much more likely to increase than to diminish.

TREATMENT.—The treatment may be expectant, mechanical, or operative.

Expectant treatment is only suitable in mild cases, where the children remain under observation and they have the benefit of continual massage and manipulation. Frequent tracings of the legs should be taken. It is important that the conditions which favor knock-knee should be prevented as much as possible, and for this reason it is advisable that the flat foot should be corrected by elevating the arch of the foot in all cases which show marked flat-foot. This may be regarded as a remedial measure which is likely to affect knock-knee. The general treatment of rickets in all cases where the disease is active is not, of course, to be forgotten.

Mechanical treatment is suitable for all cases in children under four years of age. It should be begun as soon as the knock-knee becomes at all marked, even if the child is just beginning to walk. The simplest appliance consists of an upright steel which is fastened to the shoe below and runs the length of the leg, to terminate above in a band which grasps the pelvis. A leather pad runs from this upright around the inside of the knee to pull it outward. A posterior arm from this upright, embracing the back of the leg near the knee, is an assistance to prevent flexion of the knee. The objection to the apparatus is that the knee is likely to bend, and that with the bending of the knee the deformity diminishes; consequently, to obtain the best results the knee must be kept straight.

FIG. 298.

Simplest form of brace for knock-knee.

Long-continued confinement to bed with a cushion between the knees and the feet bandaged together is often, in older cases, capable of producing satisfactory results. Elastic traction and various forms of splints have been devised, the principle of all of which is that described above.

Operative treatment is applicable to all cases of knock-knee of more than the mildest grade in children over four years of age. It is not advisable to undertake it at an earlier period. Osteoclasis is not so satisfactory as osteotomy in knock-knee, because the fracture should be located as near the joint as possible, and except with the most elaborate osteoclasts this is practically impossible.

FIG. 299.

1, Mayer, Billroth, Schede; 2, Annandale; 3, Ogston, Reeves, Chiene; 4, Macewen; 5, Taylor.

The operation most often preferred is the **osteotomy** of Macewen. An osteotome is used. It should be about half an inch in breadth, and the blade should be marked to show how deeply the edge has penetrated. A common wooden mallet is the most suitable instrument to use. The osteotome is driven into the femur at its inner aspect half an inch above the adductor tubercle of the femur. No incision in the skin is necessary unless it is preferred. By successive light blows of the mallet the osteotome cuts through nearly the whole thickness of the bone, which is then fractured manually and the leg is placed straight. Unnecessary manipulation is to be avoided. The straightened leg is placed in a plaster-of-Paris bandage and treated as a compound fracture. Hemorrhage is generally slight, and accidents may be avoided by grasping the osteotome so firmly that it cannot slip, and by cutting the posterior edge of the bone with the chisel pointed forward. Ogston's operation, which is perhaps the one best suited to very severe cases, aims at loosening the internal condyle of the femur with a chisel or saw cutting from above the adductor tubercle to the intercondyloid notch. Hahn advocates the performance of osteotomy on the outer as well as on the inner side of the femur, but this view has not met with general acceptance.

The various operations for the correction of knock-knee may be seen by a glance at the diagram (Fig. 299).

CONGENITAL CLUB-FOOT.

Congenital club-foot, or **talipes equino-varus**, is the term applied to a condition of the foot in which the sole is inverted, the front part of the foot is displaced inward and upward, and the heel elevated.

The deformity has its origin probably in an arrest of development of the feet of the fœtus in utero, resulting in the delayed rotation of the legs and feet. During the early part of intra-uterine life the feet lie in the position of equino-varus,[1]

[1] Berg. *Archives of Med.*, N. Y., Dec. 1, 1882; Parker and Shattuck, *Br. Med. Journ.*, 1886, ii. 10.

and a persistence of this fœtal condition is likely to result in club-foot. The delayed rotation of the feet may be due to various causes, such as mechanical obstruction or some abnormal condition of the nervous or circulatory system of either mother or child. If this view of the origin of the deformity is accepted, it brings it into the same class with spina bifida and other similar malformations with which it frequently coexists. Heredity is an undoubted factor in the production of club-foot, and much influence has been attributed to maternal impressions as a causative factor, although probably in most cases impressions are not the cause of the deformity. Abnormal development in the uterus, the paralysis of certain muscles, and primary bony changes have been advocated as the cause of club-foot, but the view that it originates in retarded development is the one generally accepted.

PATHOLOGY.—The deformity is a dislocation inward of the anterior part of the foot which occurs at the medio-tarsal articulation. All the tissues, muscle, skin, fasciæ, and the bones in older cases, are affected by the malposition. The alteration in shape of the bones is of the most significance, because it offers the greatest obstacle to reduction. The os calcis becomes more vertical than horizontal, and its anterior articulating

FIG. 300.

Normal foot (right) (Burrell).

facet is oblique to the axis of the bone. In the severest cases the inner side may be concave. The astragalus tips forward on a transverse axis, so that only the posterior part of the articular surface is in contact with the tibia, the anterior part of this surface making a prominence under the skin; the head and neck twist inward; the scaphoid is carried inward, and with it the cuneiform bones and metatarsals attached to them. This results in a broadening of the anterior part of the foot.

The ligaments are contracted on the concave side of the foot and stretched on the other. The muscles atrophy from lack of proper use, and bony growth is likely to be retarded. The muscular reactions are normal. The tendons are somewhat displaced, but no other abnormality is present. Synovial bursæ may form on the outer edge and back of the foot.

The SYMPTOMS and DIAGNOSIS of club-foot are the direct outcome of the anatomical conditions. The patients walk upon the outside of the feet, and in walking lift the feet high, rolling one over the other in

FIG. 301.

Talipes equino-varus (left) (Burrell).

a manner which is very noticeable. The deformity is a most unsightly one. Reposition of the foot by manual pressure is impossible in any but the slightest cases.

Talipes equino-varus resulting from *infantile paralysis* may present appearances closely resembling those of congenital club-foot. The deformity is, however, more amenable to treatment and more easily corrected.

PROGNOSIS.—Without treatment there is no hope of cure or improvement in the deformity. The foot tends all the time to become more fixed in its vicious position, and the bony changes which result serve to lock it in place. With treatment begun during childhood the prospect of a cure is always good if the intelligent co-operation of the parents can be obtained. Even in adults excellent results may be obtained by operative measures.

TREATMENT.—The treatment of club-foot consists simply in recti-

fying the deformity by the mildest measure that will serve, and *in keep-ing the foot in the correct position.*

The measures to be employed in a young infant must necessarily differ widely from those in an adult, but whatever means of correction are adopted the deform-ity should be over-corrected, however destructive may be the means required to do this. A half-cure in club-foot amounts to nothing. The various methods of correction will be considered in the order of their severity:

(1) Manipulation;
(2) Plaster-of-Paris bandages;
(3) Mechanical correction;
(4) Tenotomy;
(5) The use of extreme force;
(6) Open incision;
(7) Bony resection.

The inherent tendency of all cases of club-foot to relapse in the years follow-ing correction cannot be too strongly insisted upon.

(1) *Manipulation of the foot* should be begun as early as possible, however young the infant may be. Any mother can be instructed to replace the foot in the normal position every time that she changes the

Fig. 302.
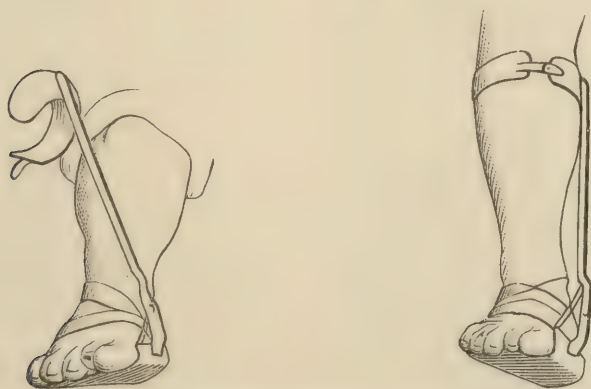
Mechanical correction of club-foot.

diaper. The outer border of the foot should be pressed upward and outward, thus correcting in the same movement the varus and the equi-nus elements of the deformity. Complete cures of bad club-foot may result from this measure alone.

(2) *Plaster-of-Paris bandages,* carefully applied, in the case of young infants may produce improvement or cure. A period of manipulation should precede their use, even in the youngest infants, to render the foot more flexible.

The bandage should be applied to the foot placed in the most correct position possible, and held in this position while the plaster is hardening. Such bandages, properly applied, stretch the contracted structures, and at the removal of the plaster a more correct position can be secured in the application of the second one. It is probable that these bandages accomplish their work in about three days, and that the most rapid progress can be made by changing them at this short interval.

Plaster of Paris is also applied to hold the foot in a correct position after ope-ration in most cases.

(3) *Correction* of the deformity *by mechanical apparatus* alone is pos-

sible in mild cases in children, and the need of some mechanical retention-appliance is necessary for correction in every case, no matter what means may have been employed (Fig. 302). The Taylor club-foot shoe is the most satisfactory appliance, both as a correction and retention shoe. It consists of a steel sole-plate to which the foot is strapped. From this sole-plate arises an upright which reaches to just below the knee. The sole-plate is adjusted to the foot in the deformed position, and then by the use of the upright as a lever the foot is brought up and the outer border raised by bringing the upright into its place at the side of the leg. This can be worn inside of the boot, and when weight is borne upon the foot the efficiency of the apparatus is increased (Fig. 303).

A roughly-made apparatus for the reduction and correction of club-foot consists in the "snow-shoe" appliance, which is merely a shingle fastened to the heel of the foot by sticking-plaster strips running down each side of the leg. The front part of this projects out, so that traction may be made by a plaster extending to the leg.

Shaffer believes in the use of an apparatus exerting intermittent force, but such intermittent force is necessarily slow in producing improvement. The use of elastic traction is, as a rule, unsatisfactory and cumbersome, and the complicated apparatus at the instrument-shops has no place in the modern treatment of club-foot.

So strong is the tendency of these children to walk with the toes inverted that it is advisable as soon as they begin to walk to carry an upright upward as far as the pelvis, where a rigid horizontal arm may be added, which, strapped around the waist, makes inversion of the foot impossible. The tendency to "toe in" persists after correction of the deformity (Fig. 303).

FIG. 303.

Club-foot shoe with upright to secure eversion (Taylor).

Whether or not mechanical correction shall be persisted in or shall give way to operative measures is in the case of most young children a question of expediency. Mechanical treatment is slow. It requires constant and intelligent care on the part of the surgeon and parent, but, if persisted in, in mild cases it yields most satisfactory results. It is not, as a rule, suitable to cases where much bony deformity is present.

(4) *Tenotomy* is the mildest of the operative measures, and is justifiable in the treatment of any case of club-foot where it is desirable to save time or where attempts at mechanical correction are unsatisfactory. In older cases and in relapsed cases it is not, as a rule, a sufficient measure. The tendo Achillis and the plantar fascia are most often the structures to be divided. In severer cases the astragalo-scaphoid and calcaneo-cuboid ligaments should also be divided subcutaneously.

After division the foot should be at once replaced in an over-cor-

rected position. The fear that non-union of the tendons may occur if this is done has no foundation. Cases which are allowed to *relapse* after tenotomy are *more resistant* than if they had never been operated upon. The foot should be held in the correct position by some stiff bandage or by a Taylor club-foot shoe. Any appliance is efficient which holds the foot in a slightly over-corrected position. After three weeks walking may be resumed if tenderness has disappeared at the site of the operation.

(5) *The use of extreme force* under ether after tenotomy is often necessary in order to tear resistant ligaments which are not within reach of the knife. This force may be applied by the hands, by Thomas's wrench, or by Bradford's apparatus, which works with a sole-plate and long lever. It is surprising how great an amount of force can be safely used in these cases. Whatever apparatus is used is only intended to supplement the force exerted by the hands, and by the intelligent use of extreme force the performance of operations upon bone has been largely done away with.

(6) *Open incision* consists simply in dividing all the resistant structures in the sole of the foot. It is spoken of as Phelps's operation. The incision need not necessarily be transverse, but can be carried obliquely forward near the inner border of the foot, through which incision all resistant structures can be divided. If the transverse cutting is done fairly well forward, the bleeding is often insignificant. The incision described by Phelps runs from the inner malleolus to the inner side of the neck of the astragalus. Through this incision may be cut all soft structures as they offer resistance.

The operation should be performed in cases where reposition is not possible after tenotomy. In the severest grade of cases, where the bony changes which have been described are present, some further measure will be necessary after open incision which only divides the soft parts. These measures may be extreme force (as spoken of above) or some operation upon bone.

(7) *Resection of bone* occupies of late years a steadily less important place in the treatment of club-foot. The performance of needlessly mutilating and extensive bony resections will not be considered here. In Young's *Orthopædic Surgery* can be found a list of sixteen different operations upon the bones of the foot for this deformity. The two operations to be considered in this article will be osteotomy of the astragalus and os calcis and excision of the astragalus. Where marked obliquity of the neck of the astragalus exists, and the front part of the os calcis is curved inward, it is not likely that division of the soft parts will rectify the deformity. In these cases a wedge-shaped piece should be removed from the outer side of the os calcis. If resistance persists after this, an osteotome can be inserted into the neck of the astragalus, which can be cut through or a wedge-shaped piece of bone may be removed from it. Correction will then be easy.

Excision of the astragalus alone yields satisfactory results in nearly all cases, but, as pointed out by Bradford, a certain amount of inward deviation of the front part of the foot persists, which is not the case after osteotomy of the os calcis. The removal of so important a bone as the astragalus is to a certain extent a mutilating operation, which seems unnecessary if osteotomy of the os calcis will answer as well. The removal of a large wedge of bone from the tarsus is considered unnecessary.

The *treatment of club-foot is, in a word, as follows:* The deformity

should be corrected by manipulation and retention by a stiff bandage in infants. Later, tenotomy or open incision may be necessary if mechanical treatment has failed or has not been undertaken. After the performance of tenotomy or open incision correction by instrumental force may be necessary. If rectification cannot be obtained in this way, osteotomy of the os calcis and astragalus must be performed.[1]

The mildest measure that will over-correct the deformity is the best, but *over-correction is essential,* no matter what means are necessary to produce it. *Any treatment is incomplete which does not provide against the occurrence of a relapse.* This can only be followed out by having the patient wear an efficient retention shoe, such as the Taylor shoe, for some two or three years at least after operation. Whatever apparatus is worn should be discontinued gradually and carefully.

CLUB-HAND.

Club-hand is the name applied to a rare congenital condition which is in a measure analogous to congenital club-foot, and which may occur in connection with it. The deformity consists in a deviation of the hand from the line of the forearm. This deviation is almost always toward the flexor surface of the arm, and the case is spoken of as dorsal club-hand when the deformity is toward the extensor surface of the forearm, and as palmar club-hand when the deviation is toward the flexor surface. It is also spoken of as radial club-hand when the deviation is inward, and as ulnar club-hand when the deviation is outward at the wrist. Radio-palmar club-hand is the most frequent form.[2]

FIG. 304.

Club-hand.

A certain amount of deformity of the bones is generally present. The carpus may be incompletely developed or it may be almost entirely wanting. In the radial forms the radius is often wholly or partly wanting, and the lower end of the ulna may be enlarged to articulate with the carpus.

A deformity simulating club-hand may result from intra-uterine fractures or cicatrices, also from cerebral irritation. The cause assigned for the occurrence of club-hand is the same as that given to account for the presence of congenital deformities in general.

The hand is not held so rigidly as is the case in club-foot, and it can be moved through a certain arc.

The DIAGNOSIS is evident from inspection.

[1] Young, *Med. News,* May 12, 1888.   [2] *Orthopædic Trans.,* vol. vi. p. 211.

TREATMENT.—In the milder cases *tenotomy* of the resistant and contracted muscles or the stretching of them by manipulation or splints may be efficient. In dividing the tendons it is better to lengthen them by open incision than to divide them subcutaneously, as the possibility of non-union is greater here than in tenotomy in general. Where the radius is deficient and the deformity severe amputation may be advisable. R. H. Sayre has resected the ulna and part of the carpus in a case of the radial variety, and has obtained a fairly useful arm (Fig. 304). Each case, of course, must be treated on its merits, and the policy to be pursued would depend largely upon the deficiency of the bones.

AFFECTIONS OF THE ARCH OF THE FOOT.

The abnormal conditions pertaining to the arch of the foot will be considered under three headings. These divisions are—(1) **pronated foot**, (2) **flat-foot**, (3) **contracted foot**. The majority of cases showing these conditions have formerly been grouped under the title of "flat-foot," which will here be restricted to signify a definite condition.

FIG. 305.

(1) **Pronated Foot.**—The name "pronated foot" will be applied to an abnormal condition where in standing the foot rolls out and the inner malleolus tends to become more prominent than it should. The line of weight, instead of passing through the inner part of the metatarsus, falls, as a rule, inside of the foot. A certain amount of abduction of the front part of the foot is necessarily anatomically associated with pronation. This condition is most easily noticed if the patient stands with the foot upon the ground, bearing little or no weight. If the body-weight is thrown upon the leg, it will be noticed that the inner malleolus becomes more prominent, while the relation of the foot to the leg changes, and, instead of continuing in the line of the leg, as it should, the foot proper tends to roll outside of it. The condition can be more easily appreciated from an illustration than from a verbal description (Fig. 305). A long-exposure plate was used, and the patient stood without weight upon the leg and with weight upon the leg. The two separate photographs are therefore shown upon the

The leg and foot without and with the superimposed weight of the body.

plate—one of the normal position and the other of the abnormal or pronated position.

Pronated foot has not been recognized as a separate pathological condition, because in most instances it has been regarded, as it most often is, as an early stage of flat-foot, but with the more extended study of flat-foot it becomes evident that many cases of painful affection of the foot due to abnormality of the arch of the foot not shown by any demonstrable alteration of the arch. These cases must be classified as pronated foot.

The study of the arch of the foot and its variations has been made for the most part by a study of the imprint of the foot as shown upon a piece of smoked

cardboard or by placing the wet sole upon a piece of paper (Figs. 306–308). This
method of studying the arch of the foot does not in any way show the existence
of pronated foot, where the imprint may be perfectly normal. For example, Fig.
306 shows the case of a woman twenty-seven years old. Pain had lasted for two

FIG. 306.   FIG. 307.

Flat-foot.   Normal foot.

FIG. 308.

Contracted foot.

Imprints of the palmar surface of flat and pronated feet.

years in connection with standing, and had extended to the knee and hip. It had
been so severe that there was much swelling of the feet at times. A smoked trac-
ing of the foot showed a perfectly normal imprint. The photograph showed a
marked degree of pronation of the foot. Here, then, is a case of disabling painful
difficulty in the feet, accompanied by a very marked degree of pronation at the
ankle-joint, which was not shown by a smoked tracing.

(2) **Flat-foot** should be restricted to those cases where a tracing of
the foot, taken as described, shows a distinct breaking down of the arch.
Pronation of the foot to some degree must be present where the arch is
lowered, for obvious mechanical reasons. Flat-foot is not necessarily a
disabling affection. It may vary in degree from a slight flattening of
the normal arch to a condition where the whole bottom of the foot
touches the ground.

The foot at birth is not flat, as has been stated in most books, but the
arch is well formed, and in reality the scaphoid lies from 1.5 to 2 cm.
above the plane of the heel. This fact has been demonstrated by Dane.[1]
For the first two or three years of life the fact that the imprint of a
child's foot is like that of an adult flat-foot does not necessarily mean
that the arch of the child's foot has broken down, although children

[1] Rotch's *Pediatrics.*

may have flat feet. In thin children the imprint of the foot at this age is not that of a flat foot, but of a normally developed arch. At four or five years of age the arch should form, and the tracing should then be that of the normal adult type.

The CAUSES of pronated and of flat-foot will be considered together. In general terms it may be said that the deformity is caused by a dispro-

FIG. 309.

Foot-print in a case of pronation : the two outlines inside show the position of the inner border of the foot with and without weight-bearing.

portion between the weight to be borne and the muscular power which bears it. The immediate causes of deformity of the arch of the foot in the order of their approximate importance are as follows :

(1) *Bad boots*, which cramp the forward part of the foot, displace the great toe outward, and fail to support the arch. The muscles intended to support the arch are disabled and do not contribute proper muscular support. The shape of modern children's boots tends to throw the great toe outward and to favor the occurrence of deformity at this early age. Fig. 310 shows the typical relation of a woman's ordinary boot to the foot of the individual wearing it. It is obvious that such relation is opposed to proper muscular support and proper weight-bearing.

(2) *Weakness or inefficiency of the muscles* resulting from—

    (*a*) Long standing, especially on hard-wood floors ;

    (*b*) Rapid growth ;

    (*c*) Poor health and debility ;

    (*d*) Convalescence from acute illnesses ;

    (*e*) Rapid gain of weight ;

    (*f*) Accident, injury, or disuse of limb.

(3) *Excessive weight-bearing*, as in the case of professional " strong " men and " jumpers."

(4) *A shortened condition of the gastrocnemius muscle.*

(5) *Rickets*, for the most part to be observed in young children.

(6) *Infantile paralysis.*

(7) *Direct traumatism.*

(8) *Locomotor ataxia* and similar organic nervous diseases.

Pronated foot and flat-foot are associated often with rheumatoid arthritis and neurasthenia. There is a type of intractable flat-foot seen in young adults, accompanied by marked muscular atrophy, where treatment is of little avail. Its etiology is most obscure.

PATHOLOGY.—The pathological changes in pronated foot show nothing more than the results of long-continued strain of the tissues at the outer side of the foot and contraction of the inside. In the severest cases of flat-foot the pathological changes are only those which result from the prolonged maintenance of the vicious position. In the beginning the changes are only an exaggeration of those occurring in normal abduction, or, if abduction of the forward part of the foot becomes prominent, a general rotation inward of all the bones on an antero-posterior axis takes place. Certain ligaments are stretched, while others are contracted ; new articular facets develop where the changed relations of the bones bring new parts into apposition ; and ultimately the bones may change in shape under the new conditions, but there is no characteristic primary pathological change. The inner border of the foot may become convex, and in the severest cases the scaphoid is almost completely dislocated outward. Even the surface of the sole may become convex in the severest cases.

FIG. 310.

The relation of an average boot to the foot: outline of boot, deep shading; outline of foot, light shading.

SYMPTOMS.—The symptoms of pronated foot and of flat-foot are the same. At the onset the pain and discomfort are more the result of the pronation than of the actual breaking down of the arch. This fact has been largely overlooked, and many cases have escaped treatment because the tracing of the foot showed a normal imprint, the pronation being entirely disregarded. The earliest symptom in pronated foot or flat-foot is generally to be found in weariness and discomfort in the feet on long standing, the feet being hot and flushed. The patient is inclined to spare

the feet, and there is often difficulty in getting the boots to fit. Boots which have formerly been worn with ease become uncomfortable and cannot be endured. Pain is the commonest symptom, but it is generally preceded by burning and discomfort in the feet. It comes on especially after standing. It may radiate up the leg and thigh. It is confined to no especial location, although it is most commonly referred to the arch of the foot. Sensitive spots are present, but they are not located, as has often been asserted, in any characteristic places. Sensitiveness under the os calcis the writer has come to regard as an unfavorable prognostic sign. The veins become enlarged and the feet sweat profusely. After resting they feel stiff and clumsy. The symptoms in general are of the character described by patients as "rheumatic." Patients begin to walk with the feet everted, as in this position less motion at the various joints of the foot is required. They turn over on the inside of their boots, and the gait is clumsy and lacks elasticity. Swelling of the feet and legs may occur, and abduction of the forward part of the foot is favored. These symptoms are all likely to be caused by a condition of pronated foot in which the arch of the foot shows no actual breaking down. Other symptoms which may be present are backache, discomfort, and even slight synovitis of one knee, especially in neurasthenic patients; pain and inflammation in the metatarso-phalangeal joint; and ingrowing toe-nail. In the severest cases of flatfoot the foot becomes rigid in the vicious position, and reposition is not possible except under ether.

DIAGNOSIS.—These symptoms, although suggestive, are not pathognomonic. If the patient is made to step upon a piece of paper with the wet sole or upon a piece of smoked cardboard with the dry sole, it can be roughly estimated whether or not the arch is broken down. The existence of pronated foot may be detected by the eye, remembering that the line of the leg should pass outside of the great toe in the normally formed foot when weight is borne upon the leg. The existence of pronation is so obvious, if one examine carefully for it, that it can hardly be overlooked.

It is probable that more definite information as to the bearing of the arch of the foot will be obtained by its study through plate glass.[1] The patient stands, bearing weight on this glass, and the observer by aid of a mirror held under it reflects the picture of the bottom of the foot in actual contact with the glass. In this way the most accurate and reliable information can be obtained. This method has, however, been too recently found out to warrant any definite conclusions. It is impossible to say that any condition of the arch will give rise to pain, or that any foot, however apparently correct in its position, will not be the source of pain. In no affection does the amount of pain seem to have less relation to the physical defect. This adds much to the difficulty of diagnosis, but, as rule, the pain is proportionate to the pronation, and in the vast majority of cases, except of contracted foot, a noticeable degree of pronation will be found present in painful conditions.

TREATMENT.—Where the mechanical cause of a condition is so obvious as in pronated foot the treatment should be particularly plain, inasmuch as it should be directed to combating these faults of position. In other words, the pronation must be corrected. This may be done—

(1) By the use of proper boots;
(2) By raising the insides of the boots;

[1] Lovett, *N. Y. Med. Journ.*, June 20, 1896.

(3) By cultivating the muscles which support the arch of the foot and throw it over on the outer side ;

(4) By the use of pads, plates, and supporting apparatus.

This treatment applies equally well to the mild cases of flat-foot as well as to those where no breaking down of the arch exists.

(1) *The Use of Proper Boots.*—The preliminary to any and all treatment must be the selection of a suitable boot. The mechanical conditions which the foot is meant to fulfil should be studied in order that the foot may be put in the most favorable possible condition for

FIG. 311.
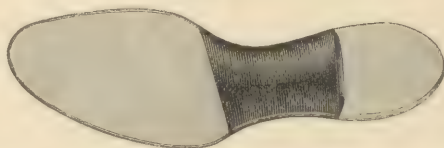
Boot of improved pattern (the inner edge is not quite so straight as it should be theoretically).

restoration to its normal relation to the leg. Hampering and disabling footwear must be discarded. In many cases this measure alone is enough to secure correction of the pronation. The essentials of a good boot are as follows (Fig. 311) :

The inside line should be straight or nearly straight.

The boot should be built to hold the foot in an adducted position ; that it is to say, the forward part should be at an angle to the hind part if their axes are shown by lines drawn in the middle of the sole and the middle of the heel. This adducted position of the foot is the position of strength and the one which tends to combat the weakness represented in pronation.

There should be plenty of width across the metatarso-phalangeal joint in order that the weight may be properly borne upon the ends of the metatarsals, and the sole of the boot should be as wide as the sole of the foot.

The shank should be broad, not cut away at its inner aspect ; it should be fairly stiff.

This, in general terms, is the accepted form of boot by most writers who have studied the subject,[1] although all sorts of modifications exist. In America, however, it has been almost impossible to buy or have made a boot of this description, and the various "hygienic" and "reform" boots have, as a rule, in no way conformed to these requirements. The shoe worn by children, which is symmetrical on both sides, tends to push the great toe out of the straight line, to hamper the muscles, and to favor pronation. The shoes worn by older children, known as misses' sizes, are as bad, if not worse. Women's boots in general, with the median pointed toe and the cutting away of the inside of the shank, favor the deformity.

(2) *By Raising the Inside of the Boots.*—If pronation persists in spite of the application of a suitable boot, or if pronation is in the first place marked, the inner half of the sole and the inner half of the heel of the boot should be raised by having put on them a wedge-shaped piece of sole leather, which should be one-eighth or one-quarter of an inch in thickness at its base, the bottom of the wedge to correspond to the inner border of the sole and of the heel, and the apex of the wedge-shaped leather to the outer border of the sole. The patient should be cautioned against walking in the bare feet. Many cases of pronation

[1] Beely, *Kirchoff der mensch. Fuss,* Berlin.

can be easily corrected at this stage by such a simple contrivance, which throws more weight on the outer border of the foot.

(3) *Muscular exercise* should form a routine part of all treatment of pronated and flat-foot in the milder cases. The addition of massage makes it more efficient, and should form a part of the routine treatment in cases where it is obtainable. The cultivation of certain faulty muscles which should normally support the arch is, however, the essential part of this aspect of the treatment. Among these exercises are forcible adduction of the foot against resistance, inversion of the sole and drawing up of the arch, walking on tip-toe, and rising on the toes. It is upon the education of the faulty muscles that the permanence of the cure must depend. Massage is of the greatest use in nearly all cases.

(4) *The Use of Pads, Plates, and Supporting Apparatus.*—In cases where the arch has broken down the application of some supporting appliance to the arch is in most cases necessary. As a rule, appliances which are incorporated in the boot are unsatisfactory and clumsy.

Fig. 312.

Supporting plates for the flat and pronated foot

Such shoes are made here and abroad, but they are exceedingly heavy and stiff. It is much better to have the supporting appliance independent of the shoe. The problem is to place the arch in a normal position which will rest the tired muscles, give the lengthened ligaments a chance to contract, and place the foot under the most favorable conditions for improvement. Plates and springs of all sizes and shapes have been devised, and it matters little which one uses.

A pad made of boiler felt may be cut of three or four layers, the bottom layers overlying the top ones, thickest at the outside, which shall be applied to the arch of the foot in such a way as to afford a properly shaped support. The felt packs down, and, although it generally gives comfort at first, is not a permanent relief. In such cases similar plates may be made of leather and worn in the boots. Apparatus of this kind is likely to break down the shank of the shoe in severe cases. Of all forms of plates, the writer finds the most useful a rigid plate made of silicon bronze, which is a trade name for a composition metal (Fig. 312). This

plate follows the outside line of the sole of the foot, coming across to the inner opposite the great toe joint. At the inside it comes to the scaphoid bone and fits the outline of the heel. The essential of any plate is that it should fit comfortably and accurately. Without this the best results cannot be obtained. This may be done by having the plate shaped to a cast taken of the foot in a fairly correct position, or, what in the writer's opinion is better, by having it shaped to the foot by the workman. Sensitive spots may be present which are not represented in the plaster cast, and if the plate presses upon these sensitive spots discomfort is caused. If the plate is tried on while being forged, these spots may be avoided, and in the writer's mind much greater efficiency be obtained.

The plates are not applied, in most cases, to cases of flat-foot as a permanent support, but in the hope that in connection with the use of muscular exercises a cure will be brought about and the plate may be dispensed with. It is a common experience for the arch to grow higher under this treatment, and at the end of three or four weeks for the plate to fail to afford proper support. Pain begins again, which is relieved by raising the arch of the plate. In many cases of flat-foot the plate may be permanently discarded after a period of six months to several years. It may be repeated that absolute comfort, due to accuracy of fit and the pursuance of special muscular exercises, is necessary to obtain this result.

FIG. 313.

Flat-foot plate with ankle support.

In the severest cases of flat-foot the plate alone is not sufficient to keep the foot in place, and an outside upright running to the top of the calf should be added. This should terminate below in a horizontal piece of steel running along the outside of the foot. This piece and the plate should be included in a leather lacing which surrounds the foot and ankle as a loose boot might, but serves to pull the internal malleolus toward the outside upright. In other words, it is a plate with an outside upright which tends to invert the foot (Fig. 313).

If, however, the foot is stiff in the deformed position, no plate or appliance can be used until the foot has been rectified *under ether* and the arch restored to at least some extent. This is done by the exercise of manual force, and retention for two or three weeks in the correct position is required. This is accomplished by the use of plaster-of-Paris bandages.

Operative measures are rarely if ever required in cases of flat-foot. Sufficient force under ether is nearly always enough to rectify the deformity, as many changes which seem to be due to bony deformity are found under ether to be only contractions of the soft parts.

Tenotomy of the peronei and other muscles, and even of the tendo Achillis, may be necessary.

Stretching of the gastrocnemius muscle manually or by Shaffer's shoe, or tenotomy of the tendo Achillis muscle, is of use in connection with flat-foot where dorsal flexion of the foot is limited to a right angle. This should be in connection with muscular exercise and massage.

Hot and cold douches are of use in restoring the circulation where it is sluggish.

Bony operations are rarely if ever advisable. They are described as follows: Ogston's operation is a wedge-shaped osteotomy removing the astragalo-scaphoid joint. The scaphoid has been removed (Davy and Golding Bird). Gleich cuts through the os calcis transversely, and slips the posterior part downward to form a bony heel. There are various other mutilating operations which cannot be here described.

Contracted foot is the name applied to the condition originally described by Dr. N. M. Shaffer as "non-deforming club-foot." It is characterized by an increase in the height of the arch of the foot, so that the imprint is changed and only the front and back part of the foot touch the ground, leaving a clear space where the foot does not touch. This condition of contracted foot may be accompanied by pronation of the foot, and in many cases is associated with a limitation of dorsal flexion of the foot.

It is diagnosticated by the tracing or by the fact that when the knee is extended the foot cannot be flexed beyond a right angle. This condition exists more often than one would suppose. In a recent series of tracings of healthy young women at least one case in ten showed what is known as a contracted foot. In the majority of instances it gives rise to no discomfort and the person is not aware of its existence.

Contracted foot, however, is often the source of discomfort, and walking may be painful in a person whose arch is apparently normal. Where it is of long standing a tight band can be felt in the plantar fascia when the foot is flexed dorsally, and pressure on this band is generally painful. At times a "clawed" condition of the toes is present in cases of long standing. Children with contracted foot fall easily and are clumsy.

Very little is known of this condition as to its ETIOLOGY or SYMPTOMS. It has been for the most part overlooked, and is likely in the future to assume more importance in orthopædic surgery. It is not unlikely that many cases of breaking down of the arch of the foot after fracture are due to the fact that flexion of the foot is limited dorsally on account of stiffness of the ankle. This condition is sometimes associated with metatarsalgia.

An acute form of contracted foot has been observed by the writer which has been relieved by the support of the arch of the foot by a felt pad.

The TREATMENT most satisfactory in chronic cases is stretching of the plantar fascia and tendo Achillis by Shaffer's shoe. Relief of the symptoms is generally immediate, and, although at first only lasting a few hours, at subsequent treatments it lasts a longer time, until after a few treatments weekly stretchings are all that are necessary. As a rule, they may be finally discontinued without relapses. Tenotomy of the tendo Achillis may be required in the severest cases.

TALIPES EQUINUS, CALCANEUS, VARUS, AND CONGENITAL VALGUS.

Talipes equinus is a condition in which the foot is plantar flexed, the metatarsus being pointed downward and the heel elevated. In a case of medium severity the patient walks upon the balls of the toes and is unable to touch the heel to the ground. There may rarely be such severe cases that the foot is completely turned over and the patient walks on the dorsal surface of the metatarsus.

In connection with talipes equinus a condition is often noticed which has largely escaped attention. The phalanges are often in a "clawed" position.

Pure talipes equinus as a *congenital* affection is rare. In the *acquired* form it results from infantile paralysis affecting the anterior muscles of the foot. It occurs as a *post-hemiplegic* contraction and in connection with *spastic paraplegia,* and sometimes with *pseudo-hypertrophic paralysis.*
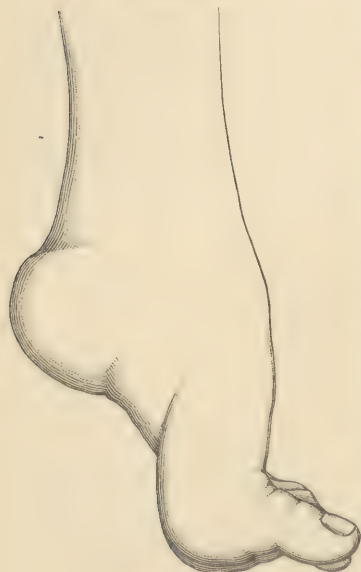
Talipes equinus.

It may be the result of traumatism from a posterior scar or it may be the outcome of a cellulitis in the muscles of the leg; it may be the symptom of muscular irritation in tubercular disease of the ankle; it may, like almost all deformities of the foot, occur as a symptom of hysteria. Patients who have been confined to bed for a long time with the weight of the bed-clothing resting upon their toes, upon their recovery may show signs of talipes equinus. The same is true of patients who, after fracture of the leg, for example, have worn for a long time a plaster-of-Paris bandage over the ankle, where care has not been taken to prevent the toes from pointing. Such patients show a temporary talipes equinus.

There is a compensatory form of talipes equinus where shortening has persisted after hip disease or some similar affection, and the foot of the shortened side, from reaching down at each step, becomes plantar-flexed.

PATHOLOGY. — The pathological changes are merely those which occur naturally from the long maintenance of an abnormal position.

The DIAGNOSIS can be made by the simplest examination, provided the knee is kept completely extended while the limitation of motion is being determined.

The slighter degrees of the deformity have been already considered under the heading of Contracted Foot.

The PROGNOSIS is good in all cases, provided efficient treatment can be obtained.

The TREATMENT of the milder cases has already been discussed in speaking of contracted foot. It is doubted if the Shaffer shoe accomplishes much in the severer cases. The limitation of mechanical treatment in talipes equinus is very marked. A satisfactory measure in nearly all cases is division of the tendo Achillis, and non-union is practically never to be feared. Division of the plantar fascia subcutaneously is often necessary in the severer cases. Where both the plantar fascia and tendo Achillis must be divided, the former should be cut first in order to be able to stretch it after cutting, without at the same time stretching the divided tendon. The tendo Achillis may be lengthened to a definite extent by splitting it longitudinally and making the transverse cuts at different levels. In this way the two halves may be slid past each other and sutured at any definite point.

Spastic Paralysis.—The question of the advisability of dividing the tendo Achillis and other contracted tendons in talipes equinus occurring in spastic paralysis has been left to the last.

In cases where the intelligence is comparatively good, and where ataxia is not a disabling factor and exists only in a mild degree, much benefit may often be derived from cutting the tendons. This not only enables the child to use its legs more normally, but seems in some cases to result in improvement of the mental condition. It does not restore any power to the legs, but simply enables the muscles to be used to better advantage. In no case within the writer's knowledge has harm resulted, and much benefit has often been observed.

After division of the tendon for a deformity resulting from infantile paralysis or spastic paralysis the foot need not be over-corrected, as in the case of congenital talipes equino-varus.

Osteotomy.—The removal of a wedge-shaped piece of the tarsus may be necessary in the severer cases of talipes equinus, but such cases are necessarily very rare.

Arthrodesis, or the production of ankylosis at the ankle-joint, may be desirable in some of the severer cases of infantile paralysis where the muscles of the leg in general are severely involved.

Talipes Varus.—Talipes varus is the name applied to a condition characterized by a turning inward of the sole, the foot being adducted and rotated inward at the medio-tarsal joint. Pure talipes varus, without an element of equinus, is a rare deformity either in the congenital or acquired form. The condition described in this article as congenital talipes equino-varus is, however, spoken of as talipes varus by such writers as Walsham and Adams. When talipes varus occurs, it results most often from infantile paralysis.

The TREATMENT of the deformity differs in no way from that of talipes equino-varus, the common form of which it resembles very closely.

Talipes calcaneus is the name applied to a condition characterized by dorsal flexion of the foot, the heel being depressed and the metatarsus elevated. There is a condition known as pes cavus, which is characterized by an arching of the sole of the foot. When severe, this is in most

FIG. 315.
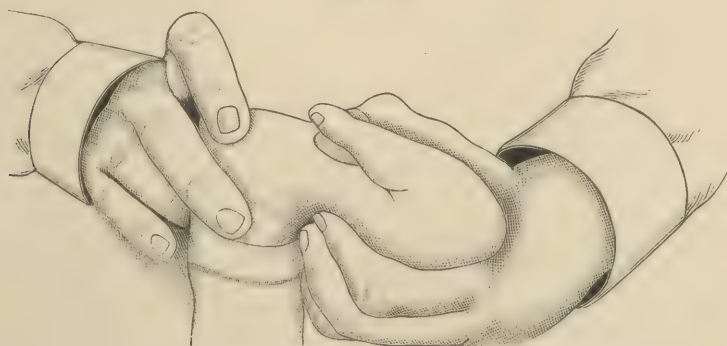
Extreme degree of talipes calcaneus.

cases connected with talipes calcaneus, and will be considered with it. Talipes calcaneus, however, may exist without any marked concavity of the sole of the foot, and pes cavus may exist without calcaneus and even with equinus.

The deformity in talipes calcaneus may vary from a slight degree of

dorsal flexion to a degree where the dorsum of the foot can be flexed to touch the anterior surface of the leg. In cases of medium severity the patient walks upon the heel with the toes elevated, and when the affected leg is placed upon the ground it is necessarily unsteady and uncertain.

The *congenital* variety of talipes calcaneus is comparatively rare. The deformity exists most frequently in the condition of talipes calcaneo-valgus. Acquired pure talipes calcaneus results most often from infantile paralysis of the posterior calf-muscles. It may occur also as a symptom of muscular irritation in tubercular disease of the ankle and from rupture of the posterior calf-muscles. It may also be the result of traumatic injuries and cicatrices [1] involving the anterior muscles of the leg. The bony changes, which are of course the reverse of those resulting from talipes equino-varus, are merely the result of the maintenance of the foot in a vicious position, and they present nothing of importance.

The DIAGNOSIS of talipes calcaneus is evident from inspection and manipulation.

In pes cavus the anterior part of the foot is drawn backward and the arch is increased. It may occur alone as a congenital deformity, and in the acquired form it is most often of paralytic origin. It may be associated with the " clawed " toes already spoken of, but it occurs most frequently as the result of infantile paralysis in connection with talipes calcaneus.

TREATMENT.—In the congenital cases of talipes calcaneus massage and manipulation are generally sufficient to overcome the dorsal flexion, possibly in connection with retention by plaster-of-Paris bandages. The same treatment may be useful in milder paralytic cases. In the latter cases a Taylor club-foot shoe, or some similar appliance which does not allow dorsal flexion of the foot beyond a right angle, is of use. Such a shoe prevents the foot from being rolled in or out and limits the vicious tendency. Tenotomy of the anterior tendons may possibly be required.

Various operations have been proposed for the relief of talipes calcaneus :

(1) The *tendoAchillis may be shortened*. (*Vide* Vol. I. p. 515.) A piece of the tendo Achillis may be removed by Willett's operation, or the tendon may be obliquely cut through, as advocated by Gibney, and the upper segment slid downward upon the lower, and the two portions sutured together by catgut while the foot is in a position of plantar flexion. Promising as these operations appear to be at first, the tendons are very apt to become elongated later where paralysis of the posterior muscles is complete.

In cases where some muscular movement is left the operation is more promising. Mr. Walsham transplants the tubercle of the os calcis to a lower position on the posterior surface of the bone, where it is fixed by an ivory peg while the foot is held in a position of extreme plantar flexion. This operation is also open to the same objection as the previous one.

(2) A *healthy muscle may be attached* to the tendo Achillis by grafting it to the side to supplement the action of the paralyzed gastrocnemius and soleus. A portion of the outer margin of the tendo Achillis is removed, and to this freshened surface the ends of the divided peroneal tendons are sutured by fine silk. Probably other muscles could be substituted for the peroneal tendons, provided that healthy muscle could

[1] Bayer, *Prag. med. Woch.*, 1873, 16.

be chosen which in their contraction should pull upward on the tendo Achillis. The grafting of a healthy muscle gives far more satisfactory results than simply shortening the tendon.

(3) *Arthrodesis* of the ankle-joint is a useful measure in cases of complete paralysis of the leg the result of infantile paralysis. This operation consists merely in an incision as if for resection of the ankle-joint. The cartilages of the joint are removed by a curette or gouge, by which mobility is destroyed and the foot is held flexed at a right angle until union occurs. When the ankle-joint is obliterated it is often desirable to do away with the mobility of the medio-tarsal or metatarso-phalangeal joints, which is likely to become a troublesome factor. This is done by destroying the synovial membrane between the bones.

Bony operations are very rarely necessary for talipes calcaneus, although in one case the scaphoid and part of the adjacent bones were removed.

Pes cavus may require for its relief the division of the plantar fascia and possibly some of the tendons.

The mixed forms of deformity of the foot described under the compound names of calcaneo-valgus, etc. have no special features of surgical interest, and have been sufficiently well covered by the description of the simpler forms.

The terms *dorsal flexion* and *plantar flexion*, wherever they appear in this article, have been used for purposes of clearness.

It is probable that the development of *tendon-grafting*—that is, grafting the proximal end of the tendon of a healthy muscle upon the distal end of the tendon of a paralyzed muscle—will have an important place in the surgery of the future.

Talipes Valgus.—Acquired talipes valgus has been spoken of already under the section relating to flat-foot.

Congenital talipes valgus, occurring without an element of calcaneus, is so rare that its existence has been denied by some writers. It undoubtedly exists, and is sometimes associated with absence of the fibula or some similar malformation.

Its TREATMENT differs in no way from that of the acquired variety.

Paralytic Deformities of the Feet and Legs.

The deformities of the feet which result from infantile paralysis have been for the most part considered in the previous section under the headings of Talipes Equinus, Calcaneus, etc. Infantile paralysis, in general the most frequent cause of these acquired deformities of the feet, causes disability in two ways : (*a*) by leading to contractions of the legs and feet in deformed positions, like talipes equinus, flexed knee, and the like ; (*b*) by rendering the limbs flaccid and unable to bear weight. The extent and distribution of the paralysis determine this disability.

The DIAGNOSIS is made partly from the history. In infantile paralysis a child in its first dentition is suddenly attacked, most often in the night, by a feverish spell, which is followed by loss of power, perhaps in one of the legs. The tendon reflexes in the knee of the affected side are lost or diminished, and the paralyzed muscles show the reaction of degeneration.

With regard to the PROGNOSIS, it may be said that no case of infantile paralysis, however severe, is beyond the possibility of improvement by mechanical or operative means.

In early cases of infantile paralysis, and in cases characterized by flaccidity rather than by contractions of the muscles, the *requirement is for apparatus* which shall give support to the leg, so that it may be used and held in a comparatively normal way. Thus the stretching of paralyzed muscles may be avoided, and contractions of the joints in deformed positions are rendered less likely.

The chief requirement in apparatus for paralysis of the leg is that it shall hold the knee extended and control the ankle, so that it shall not turn to one side or the other. This renders the leg able to bear the body-weight. The control of the ankle is best obtained by the use of the Taylor club-foot shoe, used either at the inside of the foot or outside with an outside upright. To this shoe is attached whatever appliance may be necessary to hold the leg straight. The general principle is shown in Figs. 316 and

Fig. 318.

Fig. 316.

Fig. 317.
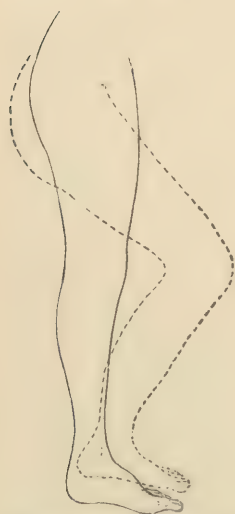
Supporting appliance in paralysis of the anterior thigh-muscles (Bradford and Lovett).
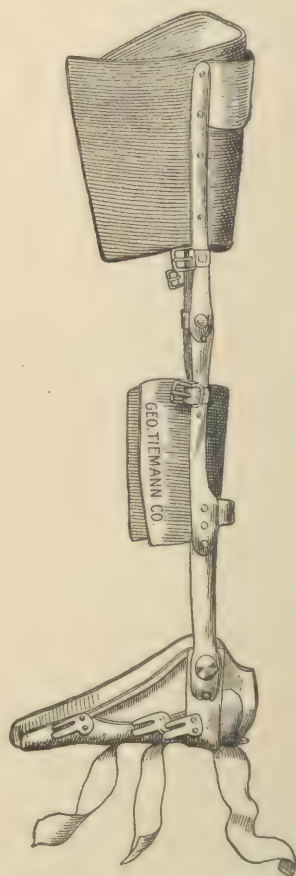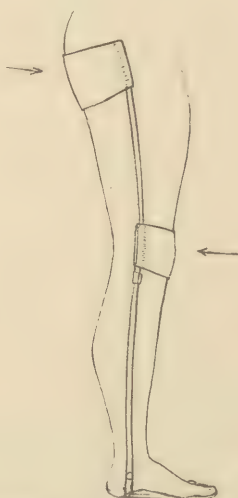
Supporting appliance for paralysis of the right leg.

317. As a supporting apparatus it is equivalent to a skeleton plaster-of-Paris bandage supporting the entire leg and ankle. Accurate fitting is essential, and leather lacings give a better distributed support than do bands and straps (Fig. 318).

Where the hip-muscles, and especially the adductors of the thigh, are paralyzed, the leg uprights should be joined to a leather jacket or a leather band embracing the pelvis.

Where contraction in a deformed position exists at any joint, it must be overcome before the legs can be properly used or fitted with apparatus. At the hip the deformity is generally flexion, and the resistant structures below the anterior superior spine of the ileum and on the outside must be cut subcutaneously or by open excision. As the operation must sometimes go as deep as the psoas tendon, the open incision is the better operation. After operation a weight-and-pulley traction should be applied.

Flexion deformity at the knee may be accompanied by subluxation of the tibia and by a marked degree of knock-knee, which may not be noticed until the flexion has been overcome, when it is very evident. Mild cases of flexion at the knee are best treated by a *subcutaneous*, or preferably an *open, incision of the hamstring tendons*, and, if necessary, of the resistant structures at the back of the joint. In the worst cases this fails to bring the subluxated tibia forward, and one has to resort to the use of extreme force or to some cutting operation. This latter is decidedly preferable, and the excision of a wedge-shaped piece of bone yields by all odds the best results. This does away with flexion deformity and knock-knee at the same time, and obliterates the motion of the joint.

At the ankle the operation has been already described as arthrodesis in the previous section.

Tenotomy as applied to the relief of spastic paralysis has been already considered in a previous section.

Hallux Valgus.

This is the name applied to an outward deviation of the great toe at the metatarso-phalangeal joint. The deviation to some extent is present in practically all adult feet at the present day, and it is only when the throwing outward of the great toe becomes extreme that it is commonly spoken of as a deformity. In the normal foot it was pointed out by Meyer that a straight line drawn backward, prolonging the middle line of the great toe, should pass through the middle point of the heel. Although this may be the case in young children, it is almost impossible to find a foot of this description in an adult, at least in the large cities. So long as children are compelled to wear shoes of the present shape hallux valgus will be commonly found. It is hard to say where the condition recognized as normal ends and where the condition to be described as hallux valgus begins. In the etiology of the affection no further cause is needed than what has already been named. The deformity is associated with osteo-arthritis in some cases, but probably does not stand in a causal relation to the condition.

Pathology.—One finds that the first phalanx is displaced more or less according to the severity of the deformity on to the outer side of the head of the first metatarsal. The internal ligaments and muscles are stretched and the external ligaments and muscles shortened and contracted. The tendons of the sesamoid bones are displaced over the inner aspect of the head of the metatarsal bone, and a bursa may develop which is apt to become inflamed on pressure and is known as bunion.[1]

The chief symptoms of the deformity result from pressure over the inner aspect of the deformed joint. The bursa often becomes inflamed and suppurates,

[1] *Revue d' Orthopédie*, September, 1892.

discharging from a small opening in the centre. This condition is likely to continue permanently. Inflammation of the distorted joint often occurs, which may result in the deposit of osteophytes and in bony grating. The bursa often communicates with the joint and suppuration may result. When the deformity is severe, it is useless to try to remedy it by making the patient wear a boot with a straight inside edge. Rather a large piece of leather should be nailed to the last on which the boot is made, which pad should come over the situation of the affected joint, allowing sufficient room to prevent pressure. Under these conditions uncomfortable symptoms are often avoided. Splints for the relief of milder forms have been devised which press the toe in by using the foot as a point from which to pull. Sayre uses a buckskin cot which connects with elastic webbing running along inside of the foot and attached to a piece of adhesive plaster on the heel.

For severe cases, where the bursa is inflamed and the joint involved, it is much simpler to excise a wedge-shaped piece from the metatarsal and the phalanx, including and obliterating the joint. Excision of the head of the metatarsal bone may be done, which may leave the patient with a fairly movable joint, but *excision of the joint*, as a rule, gives the best results and affords an opportunity for the removal of the bursa at the same time.

Hallux varus is a condition in which the great toe deviates inward to an abnormal extent. It occurs very rarely as a congenital affection. It rarely requires severe treatment. Manipulation and retention with a splint are generally sufficient. If need be, the internal lateral ligament of the foot may be divided and the toes replaced in a correct position.

METATARSALGIA.

Metatarsalgia, or Morton's painful affection of the foot, as it is often called from Dr. Thomas G. Morton, who first described it in 1876, is a condition characterized by acute pain located between the distal ends of the outer metatarsal bones. The affection seems to be due to a neuralgia of the plantar digital nerves, and especially the branches in the neighborhood of the fourth metatarsal, where they seem particularly liable to injury. The affection attacks most often young adults, and is more common in women than in men. It seems to have its origin in a certain number of cases in the persistent use of ill-fitting shoes; it arises also from slight sprains and wrenches of the foot. It may, however, occur apparently spontaneously. It may be acute and quickly subside, or it may become chronic. Local tenderness is generally present, but no swelling. The most characteristic symptom is a "cramp" in the foot, which may make it imperatively necessary to remove the boot at once wherever the patient may be.

The affection is probably in most cases associated with some abnormality in the arch of the foot, such as contracted foot, pronated foot, or flat-foot. In some instances it is associated with obliteration of the transverse arch of the foot, as pointed out by Goldthwait. It seems probable that with the more careful study of the arch of the foot some abnormality will be found to explain all cases.

In the TREATMENT the first aim should be to seek for a cause for the affection in some abnormality of the arch, and not only should this be corrected, but the use of proper boots should be insisted upon. If no cause can be found, acute cases are best treated by bandaging and soothing applications. Very severe cases may require *excision of the head of the fourth metatarsal bone*. Most cases, however, in practice can be relieved by the detection and treatment of the condition of which the pain is a symptom.

Ankylosis.

Ankylosis is the term used to designate *loss of mobility in a joint.* When this loss of motion is not complete, but where motion is limited by structural changes, the condition should be spoken of as partial ankylosis. The term true ankylosis should be used wherever firm union exists between the ends of the bones, whether it is bony or fibrous (Warren). Ankylosis often occurs—

(1) *As a result of tuberculous bone disease* where the cartilaginous and synovial surfaces of a joint have been destroyed by granulation-tissue, and a transformation of this into connective tissue and bone has taken place. It also occurs under these conditions as the result of cica-tricial contractions in the capsule of the joint and periarticular structures. Pathological luxations may also occur which impair motion.

(2) *As a result of suppurative and septic synovitis,* non-tubercular, where a similar process to that described above occurs.

(3) *As the result of rheumatoid arthritis,* where it is due to the wearing away of the cartilage and to the formation of osteophytes around the sides of the bones.

(4) *After fractures* into and near the joints, the result of synovial inflammation, of displacement of the bones of the articulation, and of cicatricial contraction in the muscles and periarticular structures.

As a rule, bony ankylosis is not present until a year or two after the acute process. Marsh, however, reported a case where bony ankylosis of the ankle-joint was present one month after suppuration began.

The most important question in connection with ankylosis is whether or not it is likely to occur as the result of prolonged fixation of a joint. The statement has been so often made that such is the case that a state of mind described as "ankylophobia" has arisen in the mind of many surgeons which leads to the premature removal of splints in fractures and in diseases of the joints. Phelps showed in some experiments on dogs that fixation of the healthy joint did not produce ankylosis. The joints were immobilized and the dogs were killed at the ends of six months, three months and a half, and two at five months, and in all cases the joints were normal and a section of the bone showed no abnormality. The conclusions which Phelps drew were that a normal joint would not become ankylosed by simply immobilizing it for five months; that movement is not necessary to preserve the normal histological character of a joint; and that where ankylosis occurs in the hip-joint it is not due to prolonged rest. Reyher found that in dogs after fixation for sixty-two days or more, although the synovial membrane remained normal, the capsule began to thicken, and that the cartilaginous surfaces where not in contact began to degenerate, but that in the cases of longest duration (about one year) inflammation did not occur.

From what has been said, and from any study of the pathology, it must be plain that ankylosis is the *result of inflammation,* especially of prolonged type. Whatever favors or increases this inflammation predisposes to ankylosis, and any measure which tends to quiet inflammation tends to arrest ankylosis. Consequently, whatever treatment is necessary to subdue inflammation in the joint should be pursued, regardless of any preconceived notion that fixation will produce ankylosis, on the ground that it is the inflammation which is the harmful factor, rather than any amount of fixation. This applies particularly to the early removal of splints in fractures, such as those of the elbow-joint, and in the case of *brisement forcé* as a measure in the treatment of stiff joints.

Brisement forcé is so often followed by equal if not greater stiffness than before operation that one seeks a physiological cause.

In the dogs experimented on by Reyher the joints were moved after prolonged fixation, and the dogs were then immediately killed, that the joints might be examined. It was found that when the fixation had lasted over a month there was infiltration of the periarticular structures and discoloration of the synovial fluid, while if the fixation had been longer, as for some months, bloody effusion took place. In general, *brisement forcé* is likely to cause exudation, and in that way to limit the amount of motion. If it be desired merely to correct the position of an ankylosed joint, the process is very serviceable, but in bony ankylosis it is useless and may lead to fracture. Force, gently and judiciously used as passive motion in the later stages of fracture, is a measure of the greatest value, but if ankylosis is feared, massage is gentler and safer. Where ankylosis has occurred, some accurate cutting operation is often to be preferred to *brisement forcé*, which may do an unexpected amount of harm. In short, the causes of ankylosis are such that the condition is not likely to be relieved by one rough manipulation, which is almost sure to start up still further inflammation.

THE MECHANICAL TREATMENT OF JOINT DISEASE.

The mechanical treatment of joint disease depends for its efficiency upon three things which it tries to accomplish. In this it follows Nature's lead, aiming to do artificially what she indicates in symptoms and pathological processes. These three aims are—(1) *fixation of the affected joint*, (2) *protection from weight-bearing*, and (3) *distraction of the joint surfaces where possible*.

Mechanical Treatment of Hip Disease.—The term "hip disease" will be used here as synonymous with tuberculous inflammation of the hip-joint. The mechanical treatment of hip disease may be conducted either during recumbency in bed or by ambulatory apparatus. In general, modern opinion leans toward the latter method.

Treatment by recumbency is to be adopted when the joint is sensitive to manipulation and when attempts at going about with suitable apparatus cause pain and irritation. It is to be adopted when deformity of the leg in an adducted, abducted, or flexed position is present; also when it is desired to avert the formation of a threatened abscess.

During treatment in bed the patient should be secured flat on his back by means of the rectangular gas-pipe frame invented by Dr. Bradford (Fig. 319).

FIG. 319.

Bradford's bed-frame.

The frame is covered with stout cotton cloth, leaving a space under the pelvis, so that the child may be placed on a bed-pan without being removed from the frame. The frame should be a little longer and a little wider than the child, and straps should

go across the chest to secure it to the frame. The use of this frame to secure fixation for the body of the child and a definite basis from which to exert traction is an essential in the scientific routine treatment of hip disease (Fig. 320). Extension is then made in the usual way by a weight and pulley from the foot of the bed.

Fig. 320.

Author's weight-and-pulley apparatus for bed-traction in hip-joint disease.

Traction should always be made in the line of deformity ; that is, the child's pelvis is placed squarely, and traction should be made upon the leg in the line in which it points (Fig. 321). As the leg improves, it may be lowered more nearly to the normal position each day. The child should be secured to the bed-frame by means

Fig. 321.

Bed-traction in a case of flexion and abduction (Lovett; by permission of the Trustees of the Fiske Prize Fund).

of perineal bands. Under the circumstances mentioned traction of from ten to fifteen pounds should be borne if possible. The traction is made by the ordinary sticking-plaster extension, as applied in Buck's method for fracture of the thigh.

Traction during recumbency may be made by the long Taylor splint about to be described under ambulatory treatment, but it is generally less comfortable than

the method just mentioned. Treatment by recumbency is not to be advocated as a routine measure, but simply under the conditions noted. It is to be discontinued as soon as the deformity has disappeared or as soon as the child can go about without pain. It is desirable, however, that children should sleep strapped to the frame at night during the acute stage of hip disease.

The ambulatory treatment of hip disease may be considered under three headings : (1) treatment by *protection ;* (2) by *fixation ;* and (3) by *traction.*

(1) *Treatment by protection alone* has been used under the name of the physiological method of Hutchison, where the child was allowed to go about using a crutch with a high sole on the well foot, and allowing the diseased leg to swing. The method is very slightly better than no treatment at all, and has been practically abandoned.

FIG. 322.
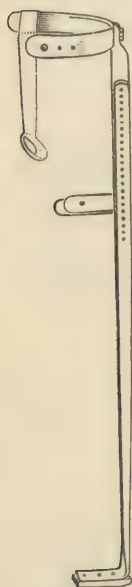
Judson's perineal crutch.

Certain methods described under the name of "traction methods" are probably nothing but methods of treatment by protection. Such, for example, is the treatment by the so-called ischiatic crutch (Fig. 322), in which scarcely perceptible traction is made by means of leather straps attached to the bottom of the splint. The traction in this case does little more than steady the leg, and it cannot be supposed to have any effect upon the joint. In this case the splint serves to transfer the weight from the hip-joint to the perineal band of the crutch, which bears upon the tuberosity of the ischium. Useful as this method is during convalescence, it is not by most surgeons considered satisfactory during the acute stage.

Treatment by Fixation.—Nature furnishes the indication that the joint should not be moved during hip disease, by holding the hip firmly by tonic spasm of the muscles controlling the joint. In general relief is experienced by fixation.

The most efficient method of treating hip disease by fixation is that of H. O. Thomas of Liverpool (Fig. 323). *The Thomas splint* consists of a bar of soft iron reaching posteriorly in the middle line of the leg from the angle of the scapula to the lower third of the leg. It is shaped to fit the curve of the buttock. Above, it terminates in a chest-band which should encircle three-fourths of the chest. There is also a semicircular thigh-band which should be placed an inch or two below the perineum, and a leg-band should terminate the splint at the bottom, which should encircle two-thirds of the calf. The splint is applied as shown in Fig. 324, secured to the body by means of a bandage connecting the ends of the chest-piece and running over the shoulders. The leg is secured to the splint by leather straps or by a common bandage, a high sole is put upon the well foot, and the patient is allowed to go about on crutches. The splint furnishes fairly good fixation ; it is cheap and simple, and is in general use throughout England, where the results are satisfactory. In America this method of treatment is not regarded with favor, as a rule. It makes no traction and supplies necessarily imperfect fixation. Again, inasmuch as no traction is exerted to counteract muscular spasm, and thus to keep the head of the femur from being crowded into the acetabulum by muscular force, and thus wearing away the upper rim, there must result in severe

cases subluxation, shortening, and elevation of the trochanter above Nélaton's line. In general, the splint is hard to adjust, difficult to keep in place, and does not allay pain as traction does.

Other methods of fixation which are advocated are a plaster-of-Paris spica bandage embracing the chest (Fig. 325) and diseased limb, a leather splint of about the same shape and accomplishing the same purpose, and various wire, iron, and leather splints aiming at the same purpose (Fig. 326).

Treatment by Traction.—The use of traction in hip disease rests upon the theory that by efficiently applied traction the surfaces of the hip-joint can be separated from each other. In this way two surfaces of diseased and softened bone are kept from wearing upon each other. Pain is diminished, the process of healing is promoted, because the greatest amount of quiet in the joint is produced by this method.

FIG. 323.

Thomas splint applied with patten and crutches (Ridlon).

FIG. 324.
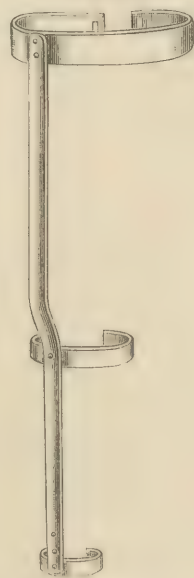
The splint in its simplest form, not yet padded or covered (Ridlon).

In connection with treatment by traction, protection should be obtained by the use of a high sole and crutches; fixation should be obtained by having a tightly-fitting pelvic band surrounding the pelvis; and the activity of the child should be limited by insisting upon some hours of recumbency during the day. The combination of the three methods of protection, fixation, and traction combined in the treatment to be described affords theoretically and practically the best chances of securing a good result in hip disease. It has been demonstrated[1] that in the diseased hip-joints of children traction of ten to twenty pounds

[1] Bradford and Lovett, *New York Med. Journ.*, Aug. 4, 1894.

induces lengthening of the leg from one-eighth to one-half inch.
Eliminating sources of error, it becomes evident that this lengthening
in the leg must be caused by a separation of the joint surfaces. Conse-
quently, it may be assumed that traction applied in sufficient force
serves to separate the head of the femur from the acetabulum, and
traction to be of use must be applied in force sufficient to accomplish
this. It is not likely that it is done by traction of less than ten pounds.
The traction must therefore be used intelligently with this in view.

Traction when the patient is going about can be most easily produced by the long traction splint know as the Davis, Sayre, or Taylor splint. The special form

FIG. 325.

FIG. 326.

The plaster-of-Paris bandage (Lovett; by permission of the Trustees of the Fiske Prize Fund).
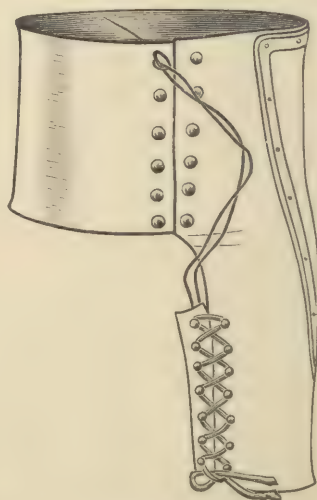
Vance's moulded leather splint.

of this splint is a matter of very slight consequence, provided that its
aim be kept in view. The object is to provide a rigid perineal band and
an upright running the length of the leg. The perineal band is to fix
the pelvis and to provide a basis for counter-extension when the leg is
pulled down by the foot-piece at the bottom of the upright.

To the leg is applied a sticking-plaster extension, such as is used in the bed-
extension. This is fastened to a windlass on the foot-piece of the splint. Perineal
bands pass from the front to the back of the rigid pelvic back, and afford a basis for
holding the pelvis when the leg is pulled downward. The splint is one which may
be made by a blacksmith, yet it is capable of the greatest nicety of construction.
The forms most commonly used are shown in the illustrations. The pelvic band
should fit tightly to the pelvis, and the upright of the splint may be curved to con-
form to the outline of the leg. The perineal bands should be made of webbing

covered with canton flannel, and any apparatus which will pull the straps downward may be used for the windlass at the bottom of the splint. The writer has described a gas-pipe splint[1] (Fig. 328), which can be made for a dollar or two, which serves fairly well, but from which traction is to be made by means of leather straps attached to the foot-piece and buckled into the sticking-plaster extension.

Such, roughly, is the splint in general use in the hands of American orthopædic surgeons. It does not furnish complete fixation to the pelvis, but partial fixation. Under proper circumstances it probably does induce separation of the femur from the acetabulum. Where it is used pain should be allayed at once, and night-cries or irritability of the joint are a sign that matters are not going well, and that the

Fig. 327.
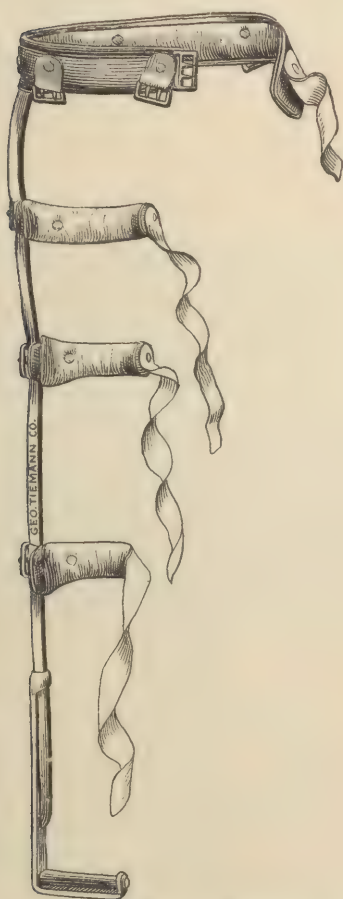
Fig. 328.

Splint for hip-joint disease.
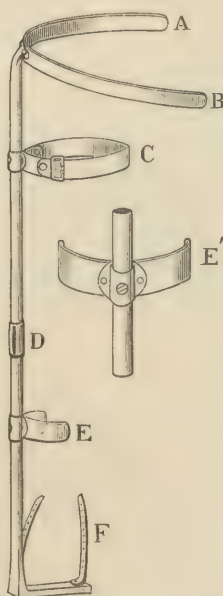
Diagram of cheap gas-pipe hip-splint.

patient is probably allowed too much activity or that the apparatus is not properly cared for.

With this treatment motion should increase in the joint, elevation of the trochanter should not occur, abscess-formation should be uncommon, and the general condition of the child should improve. If the child is allowed to walk upon the bottom of the splint, the traction will inevitably become intermittent, because when the weight is borne upon the splint the traction straps are loosened and less pull is made upon the hip than when the weight is on the other leg. Consequently, at one time the splint pulls harder than it does at others, and on theoretical

[1] *Boston Med. and Surg. Journ.*, Mar. 12, 1891.

grounds it is easy to see that this is not consistent with the best results. Crutches and a high sole upon the well foot should be used during the acute stage. It is an essential part of the treatment that the patient should during a part of the day be kept quiet in a recumbent position. The routine adopted by the writer is as follows: The patients are not allowed to get up until ten o'clock. They are quiet one hour in the morning and two hours in the afternoon, going to bed at six or seven. In this way better results are obtained than under other conditions.

The splint of Dr. Phelps is probably the most important modification of the long traction splint (Fig. 330). It aims at securing better fixation by an arm encircling the thorax in addition to the pelvic arm, and it theoretically provides lateral traction in addition to that in the

Fig. 329.
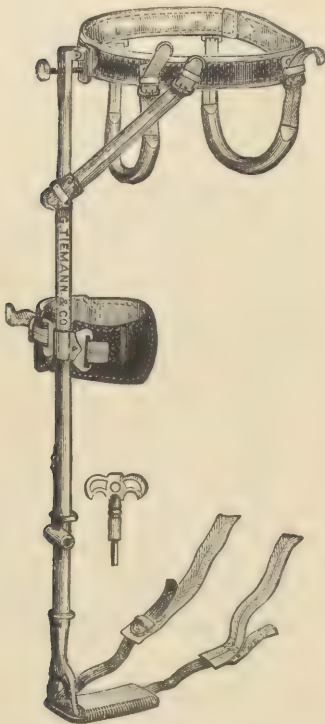
Fig. 330.

Brace for hip-joint disease, with extension and counter-extension provided for.
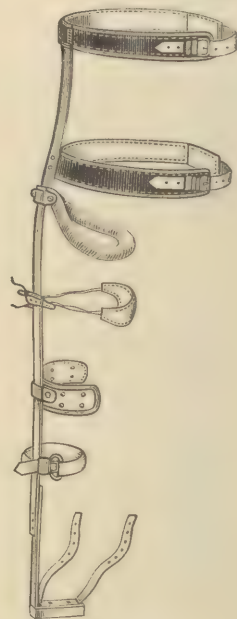
Phelp's hip-joint brace.

length of the leg. It is doubtful if the splint really exerts lateral traction; and, indeed, the question of the value of lateral traction is one which is still unsettled. There are other modifications of the long traction splint in use in Germany, but they contribute nothing essential to the traction treatment.

Treatment by traction should be used until some months after muscular spasm has disappeared from the joint, for relapses are common, and if traction is discontinued too soon, rigidity returns and the disease again becomes active. When the acute stage is sufficiently quieted to allow the application of a convalescent splint, partial protection to the

joint will be all that is required.   Consequently, if the traction splint is cut off and is made to fit into a slot fastened into the sole of the boot in such a way that the splint shall be longer than the leg and that the bottom of the foot shall not touch the bottom of the boot, sufficient protection for practical purposes may be provided.   In this way the patient in walking does not have the full impact of the step come upon the hip-joint, but takes it upon the perineal band of the splint.   A splint of this sort should be worn two or three years after the active treatment has ceased, and should be discontinued gradually.

Hip-abscess.—With regard to the occurrence of hip-abscess, it is probable that the careful carrying out of the traction method as described will in the majority of cases avert its occurrence.   In a series of cases taken from the reports at the Children's Hospital, in 574 cases under ambulatory treatment only 18.7 per cent. developed abscess.[1]   In

Fig. 331.

Ward-wagon (Children's Hospital, Boston, Massachusetts).

an earlier series of cases reported by Gibney and the London Clinical Society, 60 or 70 developed abscess.   The reason for the small percentages at the Children's Hospital is probably the fact that cases under ambulatory treatment are at once admitted to the hospital wards whenever sensitiveness or deformity of the joint occurs, and are treated by recumbency.

Malum Coxæ Senile.—The form of disease of the hip occurring in elderly persons in connection with chronic rheumatoid arthritis has generally been regarded as an intractable and hopeless affection.   It has been pointed out by H. L. Taylor[2] that rest and traction of the diseased hip, followed by protection by means of the splint described above, should be followed by much relief of the irritation, and in many cases by a permanent improvement of the diseased joint.

Disease of the Knee-joint.—In tumor albus or chronic inflammation of the knee-joint the indications are, as in hip disease, for protection, fixation, and traction.

Partial fixation can be obtained by means of the ham-splint or by

[1] Lovett, *Diseases of the Hip*, p. 117.   [2] *N. Y. Med. Journ.*, Dec. 15, 1888.

the plaster-of-Paris or leather, silicate, or dextrin bandages applied to the leg. Plaster-of-Paris bandages as routine treatment for tumor albus are not suitable for continued use, as they loosen and become dirty, and afford less fixation that one would suppose on account of the elasticity of the muscles by which the femur is surrounded. To control the joint in a proper way the bandage should extend from the ankle to the groin, and should not stop at the middle of the thigh. It should be as tightly applied as is comfortable. This bandage, in connection with the use of a high sole on the well foot and crutches, furnishes protection and fixation, and is a fairly efficient mode of treatment. It does not, however,

Fig. 332.
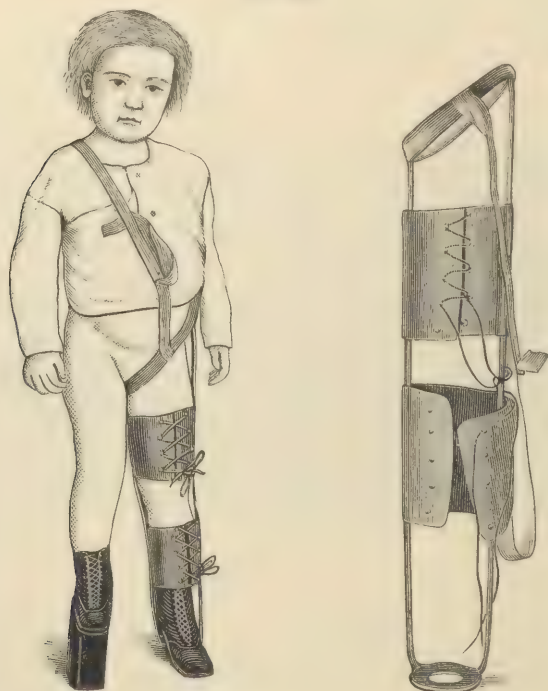
The Thomas knee-splint.

provide for traction, which, although not as important as at the hip-joint, is of use in most cases. Unless the patient has a high sole on the well foot and uses crutches the joint is not protected even if a plaster-of-Paris bandage is applied, and the case is not being properly treated if the ends of bones are allowed to jar together in the motion of walking.

The Thomas knee-splint is the most satisfactory apparatus in general for the treatment. It consists of a ring of iron set at an angle of 45° to the inner one of two uprights which project below the foot. The ring of iron is padded and fits closely the upper part of the thigh, so that in walking the patient receives support from the perineum and bears no weight upon the knee. The ring is irregularly ovoid in shape, drawn out at the inner posterior angle. This splint is shaped to the

leg and fitted with leather lacings to the thigh and the calf, which furnish excellent fixation. The splint projects below the bottom of the foot, and the transverse bar at the bottom may be used to make traction from the sticking-plaster extension, which is applied to the leg, reaching to the knee. A high shoe is placed upon the well foot, and the patient is allowed to go about either with or without the use of crutches. In cases where the muscular spasm is marked and the joint is irritable, and there is flexion, the Thomas splint is not so satisfactory as the more expensive splint shown in Fig. 333. This is practically a long traction splint, such as is used at the hip, but jointed at the knee, so that traction can be made at any angle. It is provided with buckles for pulling upward on the thigh as well as downward from the knee. The splint can make traction at any angle at which it is set, and it has the advantage of combining fixation, traction, and protection in the same apparatus (Fig. 332). A cheap splint has been

FIG. 333.

Long, jointed traction-splint.

FIG. 334.

The Taylor knee-splint.

described by Taylor where buckles sewed to webbing are incorporated in a plaster bandage, and the ends of the traction straps turned over the ends of the bandage and buckled into them (Fig. 334).

The chief difficulty in the treatment of tumor albus comes in the cases where permanent flexion of the knee occurs. Under these circumstances the following course may be pursued:

(1) The knee may be straightened by *force* while the patient is under the influence of ether, and a plaster-of-Paris bandage applied. Goldthwait's *genuclast* enables one to exert great force gradually and with safety. The apparatus extends the knee and at the same time presses forward the head of the subluxated tibia.

(2) By the application of a *plaster bandage* to the leg in the fixed position the muscular spasm is quieted and relaxed, so that after some days, when the bandage is removed, the knee can be placed in a straighter position. By a succession of plaster bandages the irritation is quieted, and at each application the knee may be straightened somewhat. This method is to be used until the leg is straight.

(3) An apparatus known as the *Billroth splint* is occasionally used.

A plaster bandage is applied to the limb, and in this bandage are incorporated two hinges attached to broad curved iron plates. These hinges are placed over the lateral aspects of the joint, so as to allow antero-posterior motion when the bandage is cut at the knee. After the bandage has hardened a circular division of the plaster is made at the knee and the front of the bandage is cut away. Into the slot at the back of the knee are inserted wedges of increasing size until the limb is straight. The splint exercises considerable pressure and may cause sloughs.

(4) Flexion may be corrected by *traction* made in the line of deformity, which quiets the irritability of the muscles and allows the limb to be gradually straightened. The way in which this traction is applied is by the traction splint above mentioned.

When muscular spasm and joint irritability have been absent for some months, the ends of a Thomas splint may be cut and turned in to a slot in the sole of the boot, so that the patient walks just as with the protection splint described under Hip Disease, with the heel of the foot not touching the heel of the boot and suspended by the perineal ring.

The treatment of ankylosis of the knee in a faulty position was discussed under the heading of Ankylosis.

Chronic rheumatoid arthritis, where it is manifested in irritation of the knee-joint, may be treated by the same apparatus, providing fixation and traction—as are used in the tuberculous variety.

Ankle-joint Disease.—Chronic tubercular disease of the ankle-joint and tarsus must be treated by fixation and protection. Traction is not applicable.

Fixation may be furnished by a plaster-of-Paris bandage applied to the ankle and reaching to the upper part of the leg, or it may be furnished by a skeleton bandage made of steel, which consists of a metal sole-plate and two uprights running to the top of the calf, where they terminate in a posterior curved band. A leather lacing holds the foot on to the foot-plate, and another lacing confines it to the calf and the uprights. This splint offers no special advantage over the plaster bandage, except that it is cooler and more comfortable.

Protection to the diseased ankle-joint is most readily furnished by having the patient wear also a Thomas knee-splint, which comes below the foot and protects from weight-bearing: unless this is done it is impossible to keep the child from walking.

When deformity of the ankle-joint, either in the position of plantar or dorsal flexion, is present, it is a symptom of muscular irritability, and this muscular irritability is most easily allayed by a succession of plaster bandages, affording fixation and applied as described in knee-joint disease, in the hope of each time securing a better position.

Disease of the metatarsus is to be treated in the same way as disease of the ankle-joint.

Diseases of the Shoulder, Elbow, and Wrist.—In diseases of the upper extremities the question of protection from weight-bearing is not, of course, to be considered, and traction is not, as a rule, practical. Consequently, one is reduced merely to treatment by fixation in chronic tuberculous disease of the upper extremities. Fortunately, they are not very common and need no extended discussion.

At the *shoulder* one ordinarily applies a plaster-of-Paris spica bandage, or holds the elbow at the side by restricting the use while the arm is confined in a sling. In certain cases where abduction of the arm is present, due to muscular spasm, it is an advantage to support the arm at a right angle to the body by means of a specially constructed wire splint, which, taking its basis from the chest, holds the arm in that position.

Disease of the *elbow* is treated by fixation, either by means of a plaster-of-Paris splint from the wrist to the shoulder, holding the elbow at a right angle, or by means of a tin internal angular splint, as in fracture of the elbow.

Disease of the *wrist* is ordinarily treated by a plaster-of-Paris bandage, or by a leather splint, or even by simple carved wood splints applied in front and behind the joint. It is desirable in these cases, of course, to limit the action of the fingers.

CHAPTER XVII.

PLASTIC SURGERY.

By Arpad G. Gerster, M. D.

History.—Among the various disciplines of the surgical art there is none more venerable and ancient than what is now termed plastic surgery. The sacred writings of India and the Ebert papyrus both mention rhinoplasty as a well-known procedure. Galen and Celsus, Antyllus and Paul the Æginete, all enter into the consideration of the subject. Malgaigne, in his introduction to Paré's Surgery, gives account of the family of Branca whose members were during the Middle Ages famous for their skilful restoration of lost noses. As the lopping off of noses and ears was a favorite punitive measure during the Middle Ages, there was no lack of suitable material for the practice of rhinoplasty.

The first systematic treatise on plastic surgery was published in 1597 by Gaspar Tagliacozzi at Venice, remarkable for containing the first account of the so-called Italian method of rhinoplasty, in contradistinction to the older Indian operation. The first Indian rhinoplasty was successfully done in London by Carpue in 1814, and shortly afterward by Dieffenbach in Germany, in whom we see the first enthusiastic cultivator of modern plastic surgery.

Definition.—In a general sense, the term "plastic surgery" comprises all *reparative measures*, whether applied to the skin, tendons, nerves, or the skeleton of the human body. In its strict application, however, we understand by it those steps which aim at the *reparation of defects and lesions of the skin only*, and of the *mucous membranes adjoining the natural orifices*. Under this now generally accepted definition Szymanovsky's term of *dermatoplasty* coincides with the modern conception of the plastic art.

The Objects of Plastic Surgery are—The repair by living tissues of (1) congenital and acquired defects of the skin and adjoining mucous membranes; (2) of the consequences of simple lesions of continuity without defect; (3) of faulty arrangements of the orifices, congenital or acquired; (4) of functional disturbances or of cosmetic blemishes due to the deposition of cicatricial tissue; (5) of perforations or fistulæ establishing abnormal communication between cavities or a cavity and the outer air.

Whenever a defect is covered by living tissues taken from the body of the patient the process is termed *autoplasty*. *Heteroplasty*, on the other hand, is the operation wherein living tissues foreign to the bearer of the defect are employed. The transfer of a skin-flap from one individual to another constitutes heteroplasty. But where a defect of

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any kind is corrected by the insertion of dead organic or inorganic matter the process cannot be termed truly a plastic one, as the element of organic cohesion is lacking. Nevertheless, some authors include these measures under the appellation of heteroplasty, though *enthesis*—insertion or coaptation—would be a better term.

Thus the insertion of a plate of metal or celluloid into a cranial defect, the healing in of a metal frame for the support of a sunken nose, and, finally, the organic enclosure of a celluloid ball into the scrotum after the removal of the testicle (Weir), all constitute *enthetic* rather than heteroplastic processes. Confusion in the terms will only be avoided by adhering to the postulate that a plastic operation consists in the implantation of living tissue upon living tissue.

GENERAL PRINCIPLES GOVERNING TECHNIQUE.—(*A*) **Transplantation and Skin-grafting.**—The fact that a totally detached part of the body can form an organic union with another than the base from which it was severed, provided that it be adapted immediately and attached by suitable means, was known early enough to serve as a foundation for the older Indian method of rhinoplasty. Accounts that a severed nose-tip, a cut-off finger-tip, were reunited to their original sites are common enough not to admit of serious doubt. Nevertheless, the success of ministration of this kind was so precarious and uncertain that—at least in Europe—no systematic plan of plastic repair was based upon this form of grafting. Knowing what important influence is exerted by the presence or absence of pyogenic infection upon the success of primary adhesion, we do not wonder that many or most of these extensive implantations turned out to be failures. Since we have learned to guard the efforts toward reunion of the living tissues against the deleterious influence of pathogenic parasites, we not only see minute particles, but extensive films, of epidermis become attached to a granulating surface. Finally, large detached flaps of skin, comprising its entire thickness, are transferred and made to become adherent with great certainty of success.

Though the honor of having established a *method* of epidermatic grafting undoubtedly belongs to Réverdin, it is of much interest to know that Frank H. Hamilton performed as early as Jan. 21, 1854, at the Buffalo General Hospital, a successful transplantation of a rather extensive detached piece of skin upon the centre of a still more extensive ulcer of the leg. He described the characteristic border growth of the graft, and upon this based the conclusion that the graft may be considerably smaller than the defect to be healed.

Réverdin's first communication on epidermatic grafting was made to the Society of Surgery on the 8th of December, 1869, and immediately attracted universal attention, and received general confirmation. The fact that the deeper living portions of a detached piece of epidermis not only retained their vitality for a considerable time, but upon being apposed to a granulating surface were capable of proliferation, entering into an organic and permanent union with the base, was universally recognized. A further extension of the method came from Ollier,[1] who, instead of Réverdin's minute morsels, successfully transplanted grafts of four, six, and eight square centimetres. But Ollier's proposition did not meet with much favor, and remained barren.

Interesting as Réverdin's efforts were, they lacked practical utility, and epidermatic grafting in a generally useful form can be said to exist only since 1886, when Thiersch demonstrated that *the cicatrization of a granulating surface* or of a fresh wound, however extensive, could be brought about with much certainty by engrafting large films of *epidermidal material* gained by the bold employment of a broad

[1] *Bulletin de l'Acad. de Méd. Paris*, 1872, 2e Série, p. 244.

razor. Thiersch's success would not have been possible without a reliable aseptic. (Thiersch's method having been already described at considerable length on p. 277, Vol. I., detailed description will be omitted.) The entire raw surface of a wound can be thus covered with epidermatic grafts. The grafts are dressed with a shingling of rubber protective washed in normal salt solution, which in its turn is covered by a liberal dressing of absorbent aseptic gauze held down snugly by a roller bandage. The dressings are not to be disturbed for three to five days. To avoid cicatricial keloid, McBurney recommends not to abandon too early the use of protective. The surface from which the graft was taken is covered with protective and the normal absorbent aseptic dressing, to be left undisturbed for a week. By that time the denuded surface is usually skinned over and firmly healed.

The advantages of Thiersch's method of transplantation are obvious : it does not sacrifice skin while procuring material for the repair of existing defects ; the process is simple and easy ; and success pretty certain. Its drawback is the circumstance that the grafts, however soundly attached, will not withstand much pressure and friction, such as is unavoidable in certain exposed localities, as, for instance, the elbow, knee, and heel. Renewed ulceration will destroy the grafts again and again, finally compelling the surgeon to resort to more radical measures.

This serious defect of epidermatic transplantation has been remedied by the introduction of the *bodily transplantation of large pieces of skin, comprising its entire thickness.*

To F. Krause belongs the honor of having demonstrated that the "older Indian method" of transplantation, consisting of the fashioning of a new nose out of skin derived and totally detached from the nates of the patient, and furthermore that Frank H. Hamilton's procedures carried to a successful issue in an isolated case were capable of being formulated into a reliable and sound method of repair [1] applicable in any situation of the integument. Asepsis, dry operating, and strict avoidance of all strong chemicals are imperative.

The locality to which skin is to be transferred must be either a fresh wound, as would result from an extirpation of lupus or cancer, or, if it be occupied by a granulating ulcer, this must be *converted into a fresh wound* by paring or energetic scraping. After completed disinfection with a sublimate solution, traces of this must be removed by irrigation with salt solution, and then the bleeding surface is covered and subjected to steady pressure by a dry sterilized compress of gauze. After this all the rest of the work must be done in a dry manner. It does not matter whether the preparatory paring and scraping leaves deeply depressed hollows or not, as experience has taught that the newly adherent flaps, though much depressed at first, become gradually raised to the normal level by a copious subcutaneous deposit of connective tissue and even new-formed fat.

The seat of the transplantation being thus prepared for the reception of the flap, the surgeon's attention is now directed to the place whence the skin-flap is to be taken. The inner and anterior surface of the upper extremity, the anterior aspect of the thigh, and the trunk will furnish an abundant supply. In disinfecting the skin too much friction is to be avoided, according to Krause.

[1] *Centralblatt für Chirurgie*, 1893, Beilage, p. 6.

On the other hand, a transient hyperæmia produced by friction or gentle flagellation is recommended by Hirschberg, its prototype being found in the practice of our ancient Hindoo colleagues, who before excising a suitable skin-flap therefrom first administered with a slipper a smart spanking to the corresponding part of the nates. It was thought that a turgid and hyper-æmic skin would better retain its vitality and would become adherent more readily.

To facilitate the immediate suture of the defect produced by the raising of the flap, this should be fusiform in shape, and, if necessary, can extend the whole available length of the extremity, its width being limited only by the requirement of leaving behind enough skin to per-mit immediate closure of the wound by suture. In obese individuals this closure of the defect will be facilitated by the excision of some of the subcutaneous fat. The detachment of the flap is done as follows: The entire circumference of the flap to be raised is defined by an incision penetrating to the fascia. Then the lower angle of the flap is seized with a dry mouse-tooth forceps, and, being raised, its adhesions to the sub-cutaneous fat are divided with even strokes of the scalpel, the edge of the knife being directed toward the flap rather than against its base. The object of this rule is to remove the skin without any adherent fat. As soon as four or five inches of the flap are raised, the forceps is dropped, and the skin-flap is doubled upon itself, so as to bring in contact its raw surfaces, the surgeon's fingers grasping the flap by its epidermidal sur-face. Thus unnecessary contact of the raw surface with fingers and instruments is avoided. Now the entire flap is detached, when it is seen to lose by shrinkage about one-third of its extent, and is immediately transferred to its new habitat, provided that hemorrhage of the base to which the flap is to be adapted has entirely ceased. To check hemorrhage torsion is preferable to ligature.

As soon as the flap is *in situ* gentle elastic pressure is applied to expel inter-vening air, and in a few minutes a remarkable degree of adhesion develops between the newly-apposed surfaces, caused partly by the cementing effect of a very thin layer of blood, but mainly by atmospheric pressure. Now, and not before, are the edges of the flap trimmed off to fit. Sutures are not necessary, except where involuntary or uncontrollable reflex movements might dislodge the flap, as, for instance, near the mouth or on the face. When a gently compressive dressing can be well applied, this will be found sufficient. Extremities are to be immobilized by suitable splints. The manner of dressing recommended by Krause was found very defective, its changing so cumbersome and dangerous to the newly adherent flap that the present writer abandoned it in favor of the usual form of aseptic dressing; that is, the application of rubber protective, and over this of dry absorbent gauze compresses fastened by a roller bandage. The presence of the protective prevents adhesion and matting together of gauze and flap, and no dif-ficulty will be encountered in the safe and painless removal of this first dressing, more or less crusted with dried blood and otherwise adherent.

The first change of dressings should take place on the fourth day. The appear-ance of the flap at this time is usually pale, sometimes bluish and livid, often cov-ered with a crop of bullæ or vesicles, and very discouraging to the uninitiated. The vesicles should be opened with the scissors and the dressings renewed. By the seventh day a rosy hue begins to penetrate the superficial necrosed film of grayish epidermis, which can now be removed with a pair of forceps. Here and there small islands of shrunken dead skin can be recognized by the absence of hyperæmia and turgor, indicative of circulation. The bulk of the flap will always survive and adhere, and it makes no difference whether the base to which the flap was transferred consist of muscle, fascia, connective tissue of any kind, periosteum, dura mater, or freshly exposed cortical or spongy bone. According to varying cir-cumstances, definitive cicatrization will require from three to six weeks. Sensation

returns but very slowly. To replace hairy portions of lost skin—eyebrows, beard, and the hair—is feasible and easy.

(*B*) **Plastic by Gliding and by the Formation of Pediculated Flaps.**—Though the scope of plastic surgery has been considerably narrowed by the adoption of skin-grafting, the usefulness of the older methods stands nevertheless unimpaired in many exigencies.

A defect acquired by disease, accident, or surgical operation can be repaired in two ways—either by **gliding** or by the **formation and transference of the flap** nourished through a pedicle.

In the first case the gap is closed by distention or the stretching of skin adjacent to the defect, which is rendered possible by a previous detachment of an adequate portion of skin from its underlying base—a process known by the name of "undermining." No new defect is caused by this process, in which the elasticity and tensile property of the skin is utilized to cover an area larger than naturally pertains to the portions of skin used for this purpose. The method of gliding represents the simplest form of plastic operation, and deserves preference whenever practicable. Nutrition of the flaps is generally abundant on account of the usually broad attachments, and no new defect need be made to furnish plastic material.

Where the method is impracticable we have to shape a flap detached on three sides of its circumference, and remaining attached at the fourth side—roughly speaking—when nutritive channels are preserved in what we term the pedicle. This flap being raised and transferred to the place which it is to invest, a defect is left at the site from which it was taken, which must be closed either by a subsidiary plastic operation, by gliding, or by another pedicled flap, or, finally, under favorable circumstances, can be made to heal under skin-grafts or by the process of granulation.

Before entering into the consideration of strictly operative details certain general rules must be laid down, the observance of which is indispensable to success.

First of all, *strict aseptic* or *antiseptic precautions* are imperative, especially where the nutritive channels are scanty. Where circulation is abundant—as, for instance, on the face—slight lapses from surgical cleanliness are easier overcome than elsewhere. Asepsis or antisepsis must be maintained after the operation so long as firm union is not secured; otherwise a late secondary infection may lead to the breaking down of recently formed adhesions. Secondly, hæmostasis must be carefully attended to, either by pressure, torsion, or ligature, before any sutures are put in. Occasionally, in well-nourished localities, suture may be used also as a means for stopping hemorrhage. But it is much safer first to staunch all hemorrhage, and then to suture the dry wound. Fine catgut is the best ligaturing material. On the head and face firm compression, exercised for ten minutes or so, will often be sufficient to check hemorrhage. The facial arteries have a strong tendency to retract, their cut ostia becoming soon plugged by thrombi. When hemorrhage is neglected more or less extensive hæmatomata are apt to develop, interposing themselves between the flap and its base, increasing tension, and retarding union, or finally serving as pabulum for infective germs.

A useful flap must be first of all *viable*—that is, well nourished. It must contain *not only the whole thickness of the skin, but also a portion of the subcutaneous connective tissue in which are distributed the nutrient vessels* of the integument. The direction of the incisions must be influenced by due regard to the course of the nutrient vessels, which ought to be preserved intact as far as possible. Flaps showing signs of arterial bleeding are well nourished; those that turn chalky and pale are less so, but may improve on the development of collateral circulation, when

their turgor and rosy coloring will be regained. But the flap must remain well nourished even after fixation and after having been subjected to the necessary amount of stretching.

While a pale flap may be of doubtful vitality, a *blue or cyanosed flap* is almost certain to decay. Cyanosis is the expression of the fact that, while arterial supply is preserved, the return circulation is embarrassed or suppressed. After a rearrangement of sutures a moderate relaxation of tension by the reduction of the number of sutures or a straightening out of a too close twist of the pedicle, will have the desired effect. If not, the flap may be bled by one or more scarifying incisions; or, finally, even the complete division of the pedicle, converting the plastic into a case of skin-grafting, may be chosen rather than the certainty of gangrene by passive congestion.

To fashion the flaps with due regard to nutrition and the avoidance of tension, they must be cut neither too large nor too small. If too large, there will be defective nutrition to the distal parts of the flap, with subsequent marginal necrosis. If too scanty, the sutures will exert so much tension as to cause acute anæmia, which will again result in disaster. It must be borne in mind that all flaps shrink very considerably after detachment, the minimum of shrinkage being one-third of the original extent.

When all the preceding points have been well observed a *correct adaptation by sutures* will have to complete the work.

As to material, silk, silver wire, silkworm gut or catgut, horsehair and kangaroo tendon, may be selected, according to the exigencies of the locality. Silkworm gut, silver wire, and silk are strong and unabsorbable, and deserve the preference when temporary or lasting tension will have to be sustained. Retention sutures should always be made of these materials, while sutures of simple coaptation, not subjected to any tension whatever, may be of catgut or horsehair or very fine silk. Buried sutures securing close contact of the deeper parts of a complicated wound—as, for instance, in the perineum—should always be made of absorbable material.

As to the *manner of suture*, its form should be selected according to the necessities of each individual case. The interrupted suture will be found most generally adaptable, though continuous sutures may be found very useful at times for certain purposes. To produce a smooth and inconspicuous scar the adjustment of the edges of the wound will have to be very exact, the contact easy and complete. Where edges of unequal length are to be brought together an evenly and neatly distributed " shirring " will have to come in. The pin suture, formerly very popular, has been all but abandoned. In its stead silkworm gut has come into much favor as a retentive suture material.

When the suture is completed in a satisfactory manner the question of dressings will need attention. Where even a slight amount of external pressure might endanger the circulation of a precariously nourished flap, any external dressing of a bulky and confining character would be inadmissible ; in fact, it is best to leave the wound exposed, protecting its surface only by a generous dusting with iodoform powder or by a filmy shingling made of rubber-tissue protective.

All *sticky substances, as plasters and collodion, are to be avoided,* as they only serve to irritate the patient and their retentive value is very problematic indeed. A properly made suture does not need the support of adhesive plaster slips or collodion, and a defective suture will not be saved by them. But where there is no objection to it a gently compressive aseptic dressing will be found a great comfort both to the patient and surgeon. The use of rubber protective should not now be

omitted, as thereby the adhesion of inspissated dressings to the newly united tissues will be prevented, and the change of dressings rendered easy and painless.

As to drainage, only this need be said, that hollow spaces ought to be eliminated by buried catgut sutures, and that by avoiding the use of too many, of too close, and of all unnecessary sutures sufficient gaps will be left for the ready escape of the first secretions.

The **time at which a plastic operation may be or ought to be undertaken** will depend upon certain considerations, which may also receive some attention. When a congenital or acquired defect interferes with nutrition or any other important function, it is proper to operate at once. After excision of neoplasms, or the removal of lupous skin, imme-

Fig. 335.
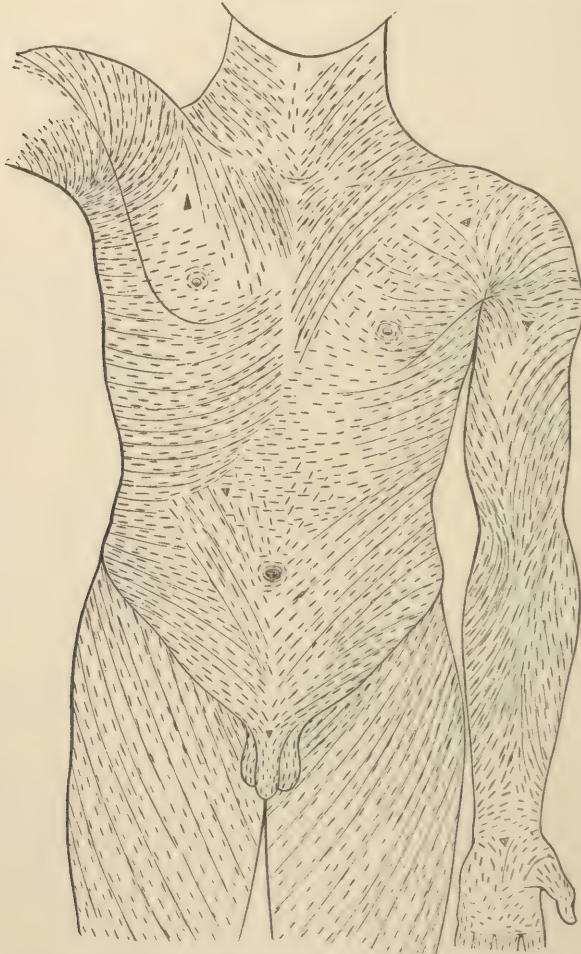
Arrangement of the bundles of cutaneous fibres (Heitzmann).

diate repair might be undertaken if the defect be not too extensive. But where the loss of integument is very great it is wise to let the wound be reduced in size by the process of cicatricial contraction before under-

taking its plastic closure, as the delayed operation will be much easier than an immediate one.

In the presence of syphilis it is the generally accepted rule, before undertaking the closure of existing defects, to eliminate first all active symptoms of the disease, especially in the vicinity of the field of operation.

Plastic by sliding is appropriate only for the repair of defects of moderate extent, and only where the skin to be used is yielding and well nourished, even when subjected to considerable tension. It is desirable to give to the defect a simple and somewhat regular contour—as, for instance, that of a triangle, quadrangle, or an ellipse. Where, to do away with excessive tension, simple undermining of the flaps is insufficient, subsidiary relieving incisions are to be made. Their direction is determined by the law of Sanger. This anatomist first described the remarkable systems of cutaneous fibres which determine the tensile properties of the skin. An incision laid parallel with the direction of a longitudinally arranged bundle of cutaneous fibres will not gap much, sometimes not at all, while if it is made transversely upon the main trend of the fibres, retraction will be very pronounced. Hence subsidiary or relieving incisions should always cross the course of the cutaneous fibres. Where several systems of fibres converge or enter into the formation of a whorl, semicircular or S-shaped incisions may be placed at some distance from the wound, and generally parallel with its longitudinal extent; or relief from tension may be secured by simply making an incision which is a prolongation and direct continuation of one or more sides of the defect. When a large defect is to be repaired, these two ways of relieving tension ought to be combined.

Triangular Defects.—Small triangular defects can be closed by
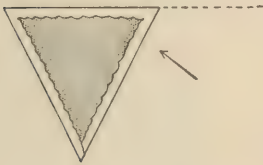
Fig. 336.   Fig. 337.

simply drawing together and suturing their angles. A small gap will remain uncovered in the centre, and can be left to cicatrize over by the
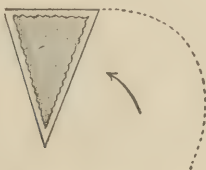
Fig. 338.   Fig. 339.

process of granulation, or else can be covered with a skin-graft. The following diagrams will readily elucidate the technical principles govern-

ing the repair of larger triangular defects. In Fig. 336 the flap is under-
mined and detached from the base, and is glided over into the opposite
angle of the defect in the direction of the arrow (Fig. 337).

FIG. 340.
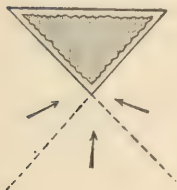
FIG. 341.

FIG. 342.

FIG. 343.

FIG. 344.
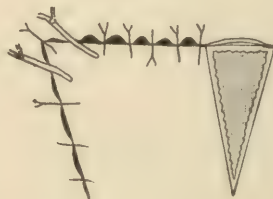
In Fig. 344 the triangle on the right side is to heal by granulation;
likewise the two small triangles in Fig. 346; or skin-grafting can be
resorted to.

FIG. 345.

FIG. 346.

FIG. 347.
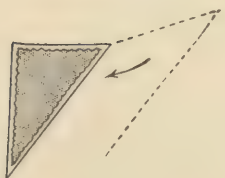
FIG. 348.

FIG. 349.
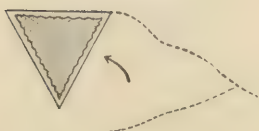
FIG. 350.

All the preceding schemes are based upon methods devised by
Dieffenbach. Burow's method of lateral triangles may, under cer-

tain circumstances, possess enough merit to warrant its adoption, but is open to the great objection that integument is unnecessarily sacrificed by it. For completeness' sake it may be illustrated here. The skin en-

Fig. 351.
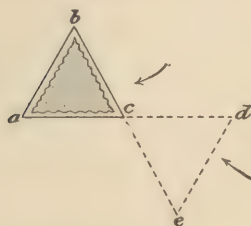
Fig. 352.
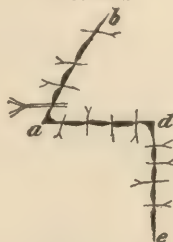
closed in triangle *cde*, as in Figs. 351 and 352, is entirely excised ; then *c* is attached to *a*, and *de* becomes opposed to the line *ce*. Where the defect to be covered is large, Burow removes two triangles of skin, one from each side of the original defect, as illustrated by Figs. 353 and 354.

Fig. 353.
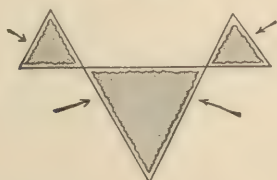
Fig. 354.

Quadrangular Defects.—In quadrangular defects, as well as in triangular ones, if they be small and the skin yielding and well nour-

Fig. 355.

Fig. 356.

Fig. 357.

ished, closure can be effected by a gradual diminution of the four corners. The small central gap necessarily persisting can be left to take care of itself or can be covered with a skin-graft (Fig. 355).

Fig. 358.
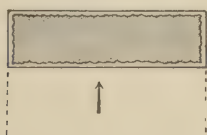
Fig. 359.
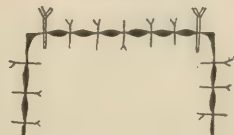
When these expedients are insufficient, subsidiary incisions, aided by undermining or even the formation of quadrangular flaps and gliding,

will have to be resorted to. In selecting the direction from which the flap is to be taken the tensile capacity of the skin should be carefully examined. Should the tension be excessive, a relieving incision, as indicated in Figs. 362 to 366, will diminish it.

FIG. 360.
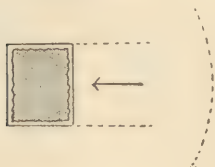
FIG. 361.

FIG. 362.
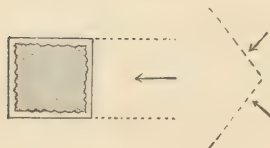
FIG. 363.
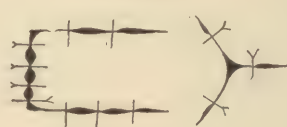
FIG. 364.
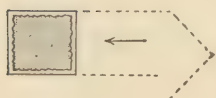
FIG. 365.
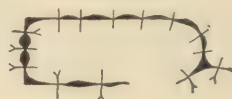
FIG. 366.
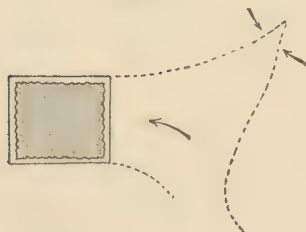
FIG. 367.

FIG. 368.
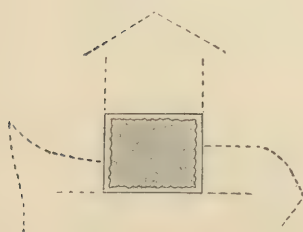
FIG. 369.
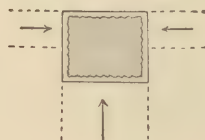
FIG. 370.

In covering a very large defect the three preceding methods can be suitably combined (Figs. 368–370).

Burow's method is also applicable for the correction of quadrangular

defects. In Fig. 371 the triangles *a* and *b* are excised before approximation of the flap.

Fig. 371.
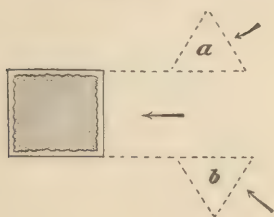
Fig. 372.
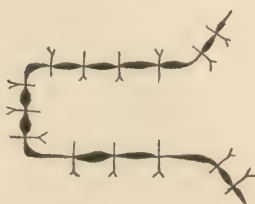
Fig. 373.
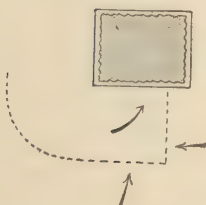
Fig. 374.

Fig. 375.
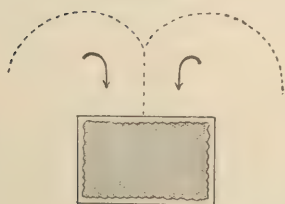
Fig. 376.
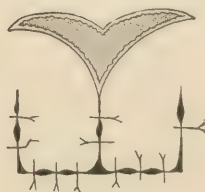
Fig. 377.
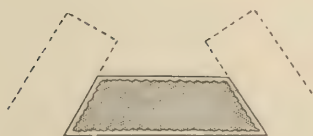
Fig. 378.
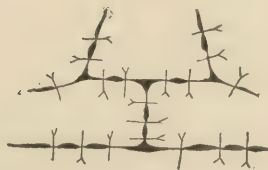
Fig. 379.
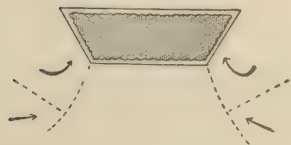
Fig. 380.

Figs. 377–382 represent Bruns' and Langenbeck's method for covering trapezoid defects.

Lanceolated, Elliptic, and Semilunar Defects.—Figs. 383–386 represent Guérin's method; Figs. 387, 388, Szymanovsky's.

Semilunar flaps (Fig. 389) were first proposed by O. Weber.

Fig. 381.
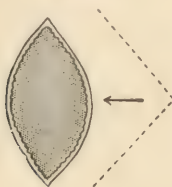
Fig. 382.

Fig. 383.

Fig. 384.
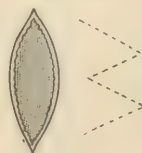
Fig. 385.
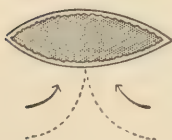
Fig. 386.
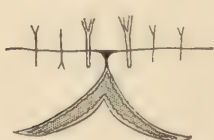
Fig. 387.
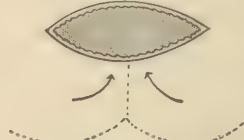
Fig. 388.

Fig. 389.
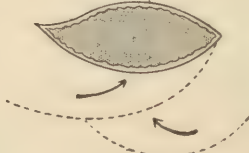
Fig. 390.

Fig. 391.
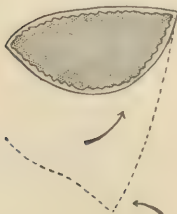
Fig. 392.

When there is an abundance of integument, Burow's excision of triangles may be successfully applied. In Fig. 393 the triangle *a* is excised; in Fig. 395, the triangles *a* and *b*.

In Figs. 394–400 the reader will see typical forms of plastic by transference of pediculated flaps. The form of the flap will have to be fashioned according to the shape of the defect which it is to cover.

Fig. 393.
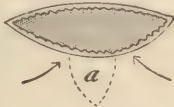
Fig. 394.

Fig. 395.
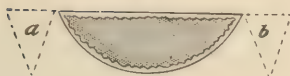
Fig. 396.
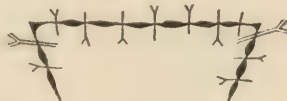
Fig. 397.
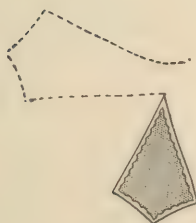
Fig. 398.

Fig. 399.
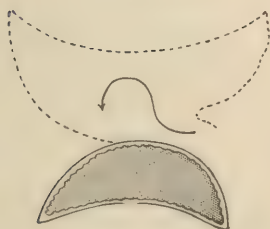
Fig. 400.
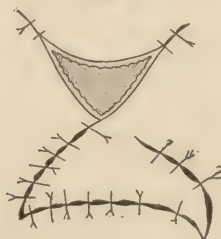
Fig. 401.

Fig. 402.

Fig. 403.

Circular and Irregularly-shaped Defects.—Where it can be done without the sacrifice of too much integument, it is best to convert a circular defect into a triangle or quadrangle, and then proceed according to the rules laid down for those. In the preceding figures the triangles marked *a* are excised. Should this not be feasible the flap method must be resorted to (Figs. 404 and 405).

In dealing with a defect of a very irregular and complicated circumference it is best to make a study of the lines it is composed of, when it

FIG. 404.
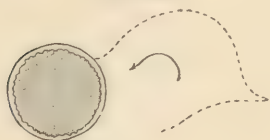
FIG. 405.

FIG. 406.
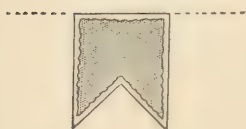
FIG. 407.

FIG. 408.
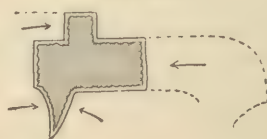
will not be difficult to dissolve the figure into its simple components, such as triangles and quadrangles. These are then to be dealt with according to known rules, as in Figs. 406–408.

CHAPTER XVIII.

THE SURGICAL INJURIES AND DISEASES OF THE EYE AND ORBIT.

By Charles Stedman Bull, M. D.

Prefatory Explanation.—Inasmuch as this is a work on General Surgery, intended mainly and especially for students, it has been thought best to strictly confine this chapter on the Surgical Diseases of the Eye to such conditions as are commonly met with in general practice. The intention throughout has been to give the student such a knowledge of the frequent and superficial diseases and injuries of the eye as will enable him to recognize what he can safely deal with himself and what he would better turn over to the care of the skilled ophthalmic surgeon. Comparatively little mention has been made of operative technique, except in regard to operations on the eyelids, as it is the belief of the author that all operations on the eyeball would be better left to the care of the ophthalmic surgeon.

ANOMALIES, INJURIES, AND DISEASES OF THE EYELID.

Congenital Deformities of the Eyelids.

Epicanthis is a congenital malformation which consists in the presence of crescentic folds of redundant skin which run downward from the

Fig. 409.
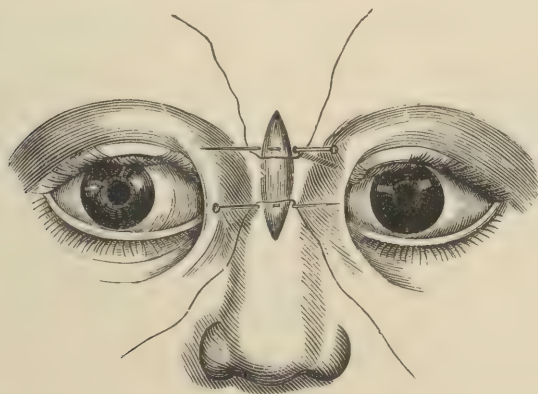
Excision of skin over bridge of nose for cure of epicanthis (Bull).

internal end of each eyebrow along the internal canthus and over the lachrymal sac, and often entirely conceal the caruncle. The deformity

varies in degree, is apt to be hereditary, and is often associated with defects in development of the eye and its adnexa, such as deficiency or absence of the levator palpebræ superioris, narrowness of the interpalpebral aperture, and marked flattening of the bones of the nose. In some cases the head is habitually thrown backward, as in cases of ptosis, in order that the patient may see objects below the horizontal meridian. When operative interference is indicated an elliptical piece of skin, with the long diameter vertical, should be excised from the root of the nose or glabella. The adjacent folds should then be freely undermined and loosened, and the lips of the wound closed by hare-lip or fine pin sutures. The result leaves a vertical scar in the median line.

Coloboma of the eyelid is a congenital deformity of rare occurrence which usually involves the upper lid, and is sometimes associated with cleft palate, hare-lip, coloboma of the iris and choroid, and dermoid tumor of the cornea. To remedy this condition the edges of the coloboma should be freshly pared and accurately brought together by fine twisted sutures passed through the tarsus, so that the lips of the fissure may be accurately united.

Tumors of the Eyelids.

Benign Tumors.—Under the head of benign tumors of the lids may be classed hordeolum, chalazion, xanthelasma, molluscum contagiosum, fibroma molluscum, warts, cysts, and angeiomata.

Hordeolum, or *stye,* is a phlegmonous inflammation of one of Zeiss' glands at the ciliary margin of the lid, where it forms a painful circumscribed swelling. It is apt to be associated with conjunctivitis or marginal blepharitis, and corresponds to a small boil. The growth may sometimes be checked by the application of iced-alum solution (one

Fig. 410.

Fig. 411.

Chalazion (seen from within) (Mackenzie).

Chalazion (Dalrymple).

drachm to the pint), but the process generally suppurates and points, and should be punctured at an early date, and then hot fomentations should be applied until the pain and swelling have subsided.

Chalazion is a chronic cystoid distention of one or more of the

Meibomian glands. It develops very slowly, is usually painless, and rarely occurs singly. It may develop in any portion of a Meibomian gland, and involve the whole gland or several adjoining glands. As it grows it causes a yellowish projection on the conjunctival surface, and if of any size soon becomes visible through the skin.

The contents may be glairy mucus or a cheesy material, or a mixture of granulation-tissue and giant cells. When the chalazion occurs at the margin of the lid it may be opened through the lid margin with a small scalpel, the contents squeezed out, and the interior scraped with a small spoon or spatula. If, however, the cyst be of any size or situated away from the lid margin, the lid should be clamped by lid-forceps, of which one blade is of horn or steel, to lessen hemorrhage, and an incision made horizontally through the skin over the chalazion, the fibres of the orbicularis pushed aside, and the entire cyst carefully dissected out. The wound in the skin is then to be closed by two or three delicate sutures.

Xanthelasma is a flat tumor of a dirty-yellow color projecting slightly above the skin of the lid, and found most frequently in the vicinity of the inner canthus. It consists in a hyperplasia and fatty metamorphosis of the connective-tissue cells of the skin. It is apt to occur in groups, and the patches may be excised and the wound closed by dissecting free the surrounding skin and bringing the edges together with sutures.

Molluscum contagiosum is a small rounded tumor with flattened surface and an umbilicated depression at the centre, from which on pressure exudes a whitish fluid.

Fibroma molluscum is a small, hard, circumscribed tumor of the skin with a pedicle, and consists of finely fibrillated connective tissue. Both these growths may be readily removed by excision.

Warts and *cutaneous horns* are sometimes met with on the edge of the lids, and may readily be excised.

Cysts of the eyelids are either of the *atheromatous* or *dermoid* character, and closely resemble similar tumors in other parts of the body. Dermoid cysts are always congenital, sometimes grow to an enormous size, and are often connected with similar growths in the orbit, and under such circumstances require great care in their removal. *True fibromata* are rarely met with in the eyelid. They are situated in the submucous connective tissue, and are apt to assume a cartilaginous character. They may be readily excised. *True lipomata* are of infrequent occurrence in the lids, and may be easily recognized by their smooth, circumscribed, lobulated form and their firmness and elasticity. They grow very slowly and can be readily removed. *Adenoma, fibrillary neuroma,* and *cysticerci* have been occasionally reported, but they are so extremely rare in this locality that they require no further consideration.

Angeiomata, or vascular tumors of the eyelids, are met with under two forms, teleangiectatic and cavernous tumors. They are always congenital, but are apt to develop very rapidly after birth, and hence should be removed as early as possible. *Teleangiectases* appear as bright-red spots in the skin of the lid. If they are small, they should be cauterized by the thermo-cautery or galvano-cautery; if they are large, they may be cauterized along a number of lines instead of over their whole surface, and the resulting cicatrization obliterates the intervening vessels.

Cavernous tumors lie beneath the skin, push it forward, and give it a bluish color. They consist of a convoluted mass of large blood-vessels which can be felt beneath the skin. In these cases the best results seem to be gained by electrolysis, though in cases of moderate size they may be excised if care be taken to use a large lid-clamp. These angeiomata are also apt to be connected with similar vascular tumors in the orbit, and in such cases excision would be a doubtful procedure.

Amyloid disease of the tarsus as a primary lesion is a very rare occurrence. The symptoms are—enormous thickening and elongation of the lids, which are very hard and cannot be everted, the absence of all signs

of inflammation and of pain, and the steady growth of the disease, which has been known to involve the orbit and eventually extend to the brain. TREATMENT here seems to be of no avail.

Lupus as a primary lesion in the eyelids is very rare, but by no means uncommon as a secondary growth extending from the nose or cheek. In the earlier stage it should be cauterized, but when more advanced it should be excised and the defect in the lid replaced by some form of blepharoplasty.

Lepra, or *elephantiasis,* in the countries where this disease is endemic has been frequently observed, nodules forming beneath the skin as the first symptom of the disease. These should be extirpated before ulceration has begun, for after this all treatment is useless.

Malignant Tumors of the Eyelids.—The only forms of malignant disease which occur primarily in the eyelids are carcinoma and sarcoma, and the latter is rare. The usual form met with in the eyelids is *epithelioma,* and it usually develops in the skin near the ciliary margin, and by preference in the lower lid near the outer canthus.

It appears as a small, circumscribed, slightly elevated induration at the edge of the lid, looking like a small wart. The surface is sometimes rough and scaly. It may remain in this condition unchanged for an indefinite period, or may show a tendency to ulcerate. It slowly creeps along the edge of the lid, its surface behind becoming broken and excoriated and covered by a thin, grayish-yellow discharge, which hardens into crusts. The tumor spreads slowly in circumference and depth, the skin around it becomes thickened and swollen, and the pain, at first slight, may become severe. The lymphatic nodes in the vicinity may or may not become enlarged. If the growth be allowed to extend, it eventually involves the conjunctiva of the lid and eyeball, the orbital tissue, and the eye itself. The progress is always very slow, and if left to itself, the prognosis is unfavorable.

TREATMENT.—So soon as the growth shows a tendency to spread, it must be removed at once by excision, through perfectly healthy tissue, from ciliary margin to cul-de-sac and through the entire thickness of the lid, and the gap in the lid made by its removal filled in by some form of blepharoplasty.

Rodent ulcer is a clinical form of epithelioma which not infrequently occurs on the eyelids. It takes the form of a shallow ulcer with uneven floor and irregular hard walls. The infiltration of the walls of the ulcer is the characteristic symptom. It is a form of epithelial carcinoma, and the ulcer advances in one direction while it cicatrizes at the opposite end. Its progress is extremely slow.

Sarcoma originating in the eyelid is a rare affection, though an orbital sarcoma frequently extends to the lids. It develops in the connective-tissue portion of the lids, especially the tarsus, and is often deeply pigmented (melano-sarcoma). Primary sarcoma of the lid occurs mainly in childhood or youth, beginning as an elastic swelling beneath the skin, which grows rapidly and soon infiltrates the interstitial tissue of the orbicular muscle. It is prone to extend to the orbital tissue, and thence to the eyeball.

AFFECTIONS OF THE MUSCLES OF THE EYELIDS.

Spasm of the orbicularis muscle may be both tonic and clonic, the latter being the more important. It is sometimes called *facial tic,* is

paroxysmal and very painful, and is sometimes accompanied by points of tenderness over the supraorbital or infraorbital nerves. The cause is often of cerebral origin. The intensity of the symptoms can sometimes be relieved by correcting refractive and other muscular errors by glasses. If the cause be peripheral, relief is gained, and sometimes a cure established, by continuous counter-irritation or neurotomy, or by exsection of a piece of the offending nerve.

Paralysis of the orbicularis muscle, or *lagophthalmos*, is caused by some lesion of the seventh nerve, which may be central, or lie in the course of the nerve, or be peripheral. When of long duration it is usually accompanied by ulceration and even abscess of the cornea.

The TREATMENT indicated is such as would be called for in any case of facial paralysis. If the cornea become affected, it may be necessary to shorten the palpebral aperture by *tarsorrhaphy*. This consists in paring the edges of the lids for a distance of ten or fifteen millimetres near the outer canthus, and then uniting them by sutures, which should be left in place for a week.

Ptosis, *or Paralysis of the Levator Palpebræ Superioris.*—*Ptosis* is the name given to that condition in which the upper lid droops or hangs down over the eye, so that the interpalpebral aperture is narrowed and the cornea is more or less concealed from view. True ptosis is due to paralysis of the levator muscle of the upper lid, and is usually associated with paralysis of other branches of the third nerve, though it may exist alone. It may be partial or complete. In the former the lid may be slightly raised by voluntary action, and this is assisted by the action of the frontalis muscle, and the forehead comes to have a wrinkled appearance.

ETIOLOGY.—Its cause may be either peripheral or central. If the latter, some of the other branches of the third nerve are usually involved, and sometimes all. If the former, it is due to pressure, on the branch of the third nerve going to the levator, by an exostosis or small tumor somewhere at the base of the skull or near the apex of the orbit, and in very rare instances by periostitis at the bottom of the orbit. Still, cases of isolated ptosis, without other signs of oculo-motor paralysis, are frequently caused by central disease.

A difference should here be recognized between congenital and acquired ptosis. The former is not caused by paralysis of the nerve, but is due to the arrest of development or entire absence of the levator muscle. It usually involves both sides, and is often transmitted by heredity.

A form of spurious ptosis is often met with in chronic trachoma or after purulent conjunctivitis, in which the lid droops by its own weight after the disease which caused it has subsided. The lid can be raised, but not to its full height. Here the muscle is not paralyzed, but is hindered in its action by the abnormal thickening of the lid.

TREATMENT.—If the ptosis be of recent occurrence, we should attempt its cure by the internal administration of potassium iodide or mercurials, or both, and by the application of the galvanic current to the muscle, one pole being placed behind the ear and the other over the closed lids. If in the course of two or three months there be no improvement, we must resort to surgical interference.

A great many surgical operations have been suggested for the relief of ptosis, but most of them are only partially successful. If the ptosis be only slight and par-

tial, Von Graefe's operation may perhaps suffice. A transverse incision is made in the skin, 5 mm. above the border of the lid and parallel to it, from one end of the lid to the other; the lips of this wound are separated and the fibres of the orbicularis muscle are extensively exsected. A strip of skin may also be excised. The wound is then closed by sutures, which are passed not only through the skin, but also through the orbicularis fibres. The effect of this operation is to cause a subcutaneous shortening of the upper lid, weaken the action of the orbicularis, and thus assist that of the levator.

In all cases of marked paralysis of the levator, resort must be had to some method of operating which will bring the lid more or less directly in connection with the fibres of the frontalis muscle. All attempts hitherto made to advance the tendon of the levator muscle have proved more or less unsuccessful. The operation which perhaps gives the best results was devised by De Wecker, and is done in the following manner: A portion of skin and muscular fibre is removed from the upper half of the tarsus, its breadth depending on the fulness of the lid. A strong

FIG. 412.

De Wecker's operation for ptosis (De Wecker).

thread is entered above the brow, pushed beneath it and the skin of the lid, keeping close to the tarso-orbital fascia, and is brought out at the upper edge of the wound; this passes over the muscular fibres, then under the skin and muscle at the lower edge of the wound, emerges, and then passes transversely along for 5 mm. over the skin, and then is carried in a reverse direction over the same course. Two such sutures are introduced. They are tied over a piece of rubber tubing, and tightened from time to time as they become loose. The wound is thus pulled together, and as the sutures cut through the tissues scars are formed which hold the lid up permanently.

ENTROPION.

This is the term employed to describe a condition in which the entire edge of the lid is turned *inward*, so that not only the cilia, but the skin-edge of the lid, is brought in contact with the cornea. It is one of the sequelæ of chronic trachoma, and is generally due to the cicatricial contracting tendencies of that disease. In this condition the lashes are inverted, the palpebral aperture is shortened, the tarsus is thickened and incurvated, and the lids hug the eyeball closely. The results are ulceration, vascularity, and opacity of the cornea, and in bad cases a tendency to the development of a staphyloma.

Besides this form of entropion, there are two other varieties, the *senile* and the *spastic*. Senile entropion comes from relaxation of the tissues, the skin becoming folded and drooping, and the action of the orbicularis aids in the effect. Spastic entropion is met with in cases of chronic keratitis and other superficial inflammatory processes.

TREATMENT.—The essential cause of ordinary entropion is deformity of the tarsus, and all operations must be adapted to modify and correct

this deformity. The operations of Arlt, Jaesche, and many others begin by splitting the lid vertically into two layers, an anterior and a posterior, for a distance of 3 to 4 mm. from the ciliary margin. A horizontal incision is then made through the skin of the lid throughout its entire length, parallel to and a short distance above the ciliary margin. The ends of this incision are then united by a curved incision through the skin on a level with the upper edge of the tarsus, and the enclosed strip of skin is then excised. The horizontal bridge of skin is then carefully separated from the underlying muscle, and, remaining attached at its extremities, is drawn up and sutured to the upper skin margin of the denuded space (Fig. 413).

Where no serious deformity of the tarsus exists this method of transplantation of the cilia serves an excellent purpose. If, however, the abnormal curvature of the tarsus be marked, this method will not suffice, and we must resort to the excision of a horizontal wedge-shaped piece of the tarsus or to its entire removal. A less radical procedure is the operation devised by Dr. John Green, the main feature of which consists in a horizontal incision which is made through the entire thickness of the tarsus on its conjunctival side, parallel to the lid border and about 2 mm. above it. A full description of this method would be too long for this place, and may be found in any complete work on ophthalmology. Hotz's operation is performed by seizing the lid at its middle between the thumb and finger, keeping it on the stretch, and making a horizontal incision through the skin from one end to the other, about 2 mm. above the ciliary margin. When the lid is released the skin contracts, causing the upper edge of the incision to become curvilinear. The muscular fibres are then carefully pushed away from the upper third of the tarsus. Three or four sutures are next carried through the skin at the lower margin of the wound, the needles being again inserted through the outer fibres of the tarsus at

FIG. 413.

Jaesche-Arlt operation on the upper eyelid (Arlt).

FIG. 414.

Graefe's operation for entropion (Wells).

its upper part, and the sutures passed through the tarso-orbital fascia and brought out through the skin at the upper edge of the wound. The stitches should be removed on the second day.

The *senile* variety of entropion may generally be relieved by the application of contractile collodion on the skin surface or by the excision of a properly proportioned piece of skin, and bringing the edges of the horizontal wound together by sutures.

Spastic entropion is more obstinate in resisting treatment, and may generally be relieved by an operation devised by Von Graefe, which consists in removing a triangular piece of skin from the lid, the base being parallel to and just above the lid margin in the upper lid or below it in the lower lid, and the apex pointing upward or downward as the case may be, and then closing the wound by sutures (Fig. 414).

ECTROPION.

This is the term applied to *eversion* of the lid, with exposure of the conjunctival surface, and the condition may be either partial or complete according as a part or the whole of the lid is involved. It may be either acute or chronic.

Acute ectropion is usually muscular in character, and is met with in children with conjunctivitis and in diseases of the cornea with blepharospasm, in which the lids sometimes become everted and remain so until replaced. Another form of muscular ectropion is met with in facial paralysis.

Chronic ectropion is sometimes seen in old persons with relaxed lids, with or without conjunctivitis.

The commonest CAUSES are wounds, both incised and lacerated; burns with subsequent cicatricial contraction; chronic inflammation of the ciliary margins of the lids; ulceration of the lids, such as lupus; tuberculous and syphilitic nodules; and caries of the orbital margins. The lower lid is more frequently involved than the upper lid.

The TREATMENT will be considered under the general head of Blepharoplasty, or Operations upon the Eyelids.

Distichiasis is a term applied to that condition in which there is a double row of cilia on the edge of the lid, one of which is developed from the intermarginal part, close to the openings of the Meibomian glands, and the cilia in which sweep the eyeball. The condition is usually caused by chronic marginal blepharitis and blepharo-adenitis, chronic granular conjunctivitis or trachoma, and burns. In rare instances it is congenital. The rubbing of the cilia against the cornea produces constant irritation, and may give rise to ulceration.

Trichiasis is a condition which differs from *distichiasis* in the irregular position and shape of the cilia which touch the eyeball. The latter may be partially or entirely inverted and in different directions. There may be thickening of the tarsal border, but the tarsus itself is not altered much in its curvature, and this makes the difference between trichiasis and entropion.

The CAUSES of trichiasis are the same as for distichiasis.

The TREATMENT for distichiasis and trichiasis, unconnected with entropion, consists of epilation; snaring the wild hairs with the loop of a thread; destruction by hot needles or by electrolysis; and excision of the follicles.

Epilation gives only temporary relief, and must be repeated every few weeks.

Ensnaring the lashes in a loop of thread was devised by Snellen, and consists in introducing a needle, through the eye of which both ends of a fine silk thread have been passed, in the edge of the lid near the displaced hair, and bringing it out through the skin some distance from the lid margin, and as the loop is drawn toward the base of the hair the latter is put within the loop and drawn up into the substance of the lid.

Destruction of the hair-follicle by *electrolysis* is very useful for individual hairs. The needle which is pushed into the follicle must be connected with the negative

pole of a constant battery, and the current should be passed for a minute. The positive pole may be placed on the temple or cheek. Two or three cells will furnish sufficient current.

Excision of the follicles is done by taking out a rectangular portion of the tarsus, without injuring the Meibomian follicles, according to the plan of Anagnostakis. The overlying skin is dissected up in a little flap, and this may be extended upward, and after the excision of the piece of tarsus the flap is dragged down, its tip is cut off, and the flap is turned in to cover the lid border, and held in place by a suture at each angle.

Blepharoplasty is the general term applied to the surgical procedures which are undertaken for the relief of ectropion and similar conditions of the lids, which require the restoration of the lids to their normal position or the formation of a new lid, in whole or in part, from the neighboring tissues.

Ectropion of a moderate degree, involving only part of the lower lid, may generally be relieved by the excision of a piece of conjunctiva or of a V-shaped piece from the entire thickness of the lid, and then carefully bringing together the raw edges by hare-lip pin sutures. Complete ectropion of the entire lid, due to extensive scars or other causes, requires a much more extensive operation (Figs. 415 and 416). In ectropion of the lower lid Arlt's operation gives excellent results. A triangle is formed by the incisions *ab* and *bc*, and a piece from 2 to 3 mm. deep is removed. The triangular flap is loosened as far as neces-

Fig. 415.

Arlt's operation for ectropion (Arlt).

Fig. 416.
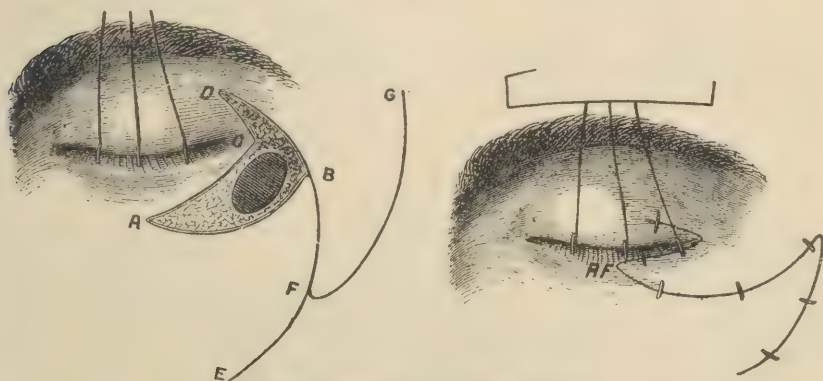
Richet's operation for ectropion (Arlt).

sary, and the wound is sutured so that *c* comes up to *d*, and the side of the flap marked *bc* lies against the skin-wound, *cd*. The gap left by the closing of the flap is to be closed by hare-lip pins.

Richet's operation for ectropion of the lower lid is as follows (Fig. 416): The cicatrix is excised by three curvilinear incisions—one, *BA*, at the orbital margin below the scar; one, *CA*, between the scar and the margin of the lid; and one, *DE*, which, starting on the upper lid, is carried in a curve down upon the cheek so as to reach the outer end of the second incision at *B*. The scar is dissected out and the lid is replaced and held in position by temporary sutures pass-

ing through the margins of both lids. A fourth curved incision, *FG*, starting from the junction of the upper two-thirds with the lower third of the last incision and extending upward on the temple, is next made. The last flap, *DFG*, is stitched into the defect made by excision of the scar, thus bringing *F* to *A*. The lower flap, *ABE*, is loosened and pulled up to cover the gap left in the skin of the temple.

Fig. 417.
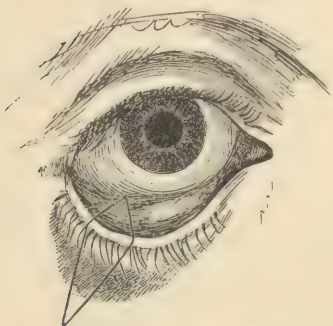
Fig. 418.
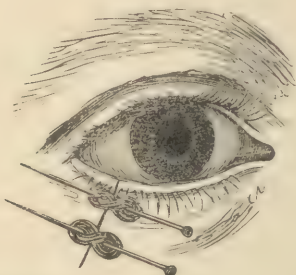
Operation for ectropion of lower lid (Richet).

Fig. 419.
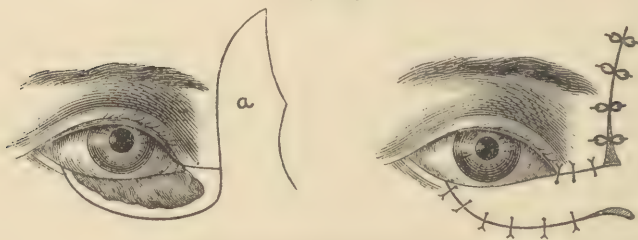
Fricke's method of blepharoplasty (Arlt).

Fig. 420.
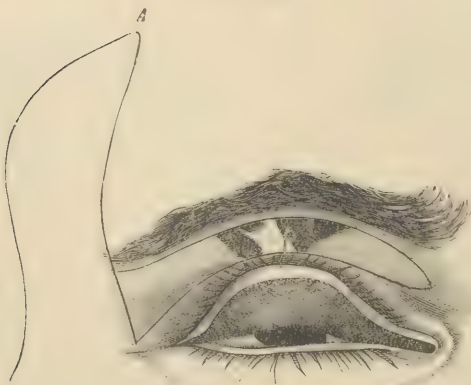
Utilization of flap from temple (Stellwag).

True blepharoplasty consists in making a new lid, and numerous operations have been devised for the purpose. The new flap may be taken from the temple (Fig. 420) or forehead or side of the nose or cheek, or it may be transplanted from some distant portion of the body without a

pedicle, as from the side of the cheek or anterior surface of the forearm. Such an operation becomes necessary after the removal of epitheliomata or other tumors. These flap operations may be briefly divided into three groups.

Fig. 421.
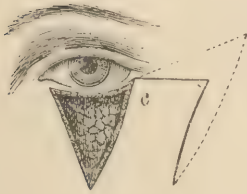
Fig. 422.

Dieffenbach's method of blepharoplasty (Arlt).
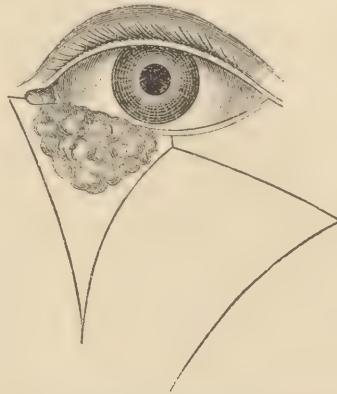
Arlt's method when a portion of the eyelid is to be sacrificed (Arlt).

(1) Those in which a somewhat tongue-shaped flap is carried in from the side of the nose for repair of the lower lid or from the temple for restoration of the upper lid (Fig. 419).

Fig. 423.

Fig. 424.
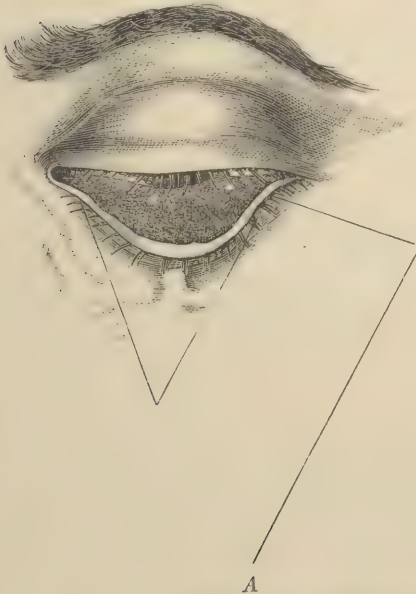
A
Utilization of quadrangular flap from cheek (Stellwag).

(2) Those in which a quadrilateral flap is moved over or shifted, so as to cover in a triangular defect in the lower lid (Figs. 421–424).

(3) Those in which the surrounding skin is extensively incised, undermined, and dissected up, and the flaps thus made are drawn or slid together so as to cover the space to be filled. The latter is especially

Fig. 425.
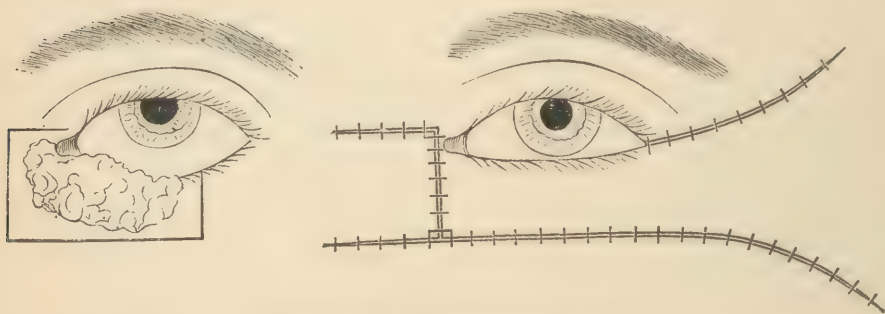
Knapp's method of blepharoplasty (Knapp).

useful in cases of neoplasms of the lower lid, and the best method is that devised by Knapp (Fig. 425).

In the repair of lesions about the inner halves of the lids, or in cases where there is no skin available for flaps either on the forehead or temple or outer part of the cheek, Dr. H. D. Noyes makes use of a naso-buccal flap in which the incisions are made down the side of the nose and cheek as far as the upper lip, the free end being below and the attached end or base above. The incisions are so made as to include vessels which come from the supraorbital, ethmoidal, and nasal branches of the orbital arteries, and also some branches from the other side of the median line, by making the incision obliquely across the nose. When this flap is twisted on its base upward and placed in position, there is left a large gap in the face, which is filled by sliding the cheek in toward the median line and uniting the edge by pins and figure-of-8 sutures.

Diseases of the Conjunctiva.

In all forms of conjunctivitis there are one or two rules of treatment which the student and practitioner would do well to remember. The first is *always to use cold or even iced fomentations,* unless there is distinct and urgent need to hasten suppuration. Another is *never to use atropine unless the cornea shows evidences of becoming involved.* The tendency among most physicians is to use atropine in all forms of inflammatory affections of the eye, and to use warm or hot fomentations in conjunctivitis; and both these tendencies should be frowned down and prevented as far as possible.

But three forms of conjunctivitis will be considered in this chapter, and these very briefly—viz. Purulent Ophthalmia, Diphtheritic Conjunctivitis, and Chronic Granular Conjunctivitis, or Trachoma.

Purulent Ophthalmia.—Under this head are included the purulent conjunctivitis of new-born infants and the purulent inflammation of the adult, both non-specific and gonorrhœal.

The symptoms in all are the same, and differ only in intensity. There are marked injection of the palpebral and ocular conjunctiva; chemosis of the conjunctiva; swelling; infiltration and discoloration of the lids; a purulent discharge, more or less profuse, which glues the lids together;

heat ; and pain, which at times is very severe. The lids become even purple in hue, and so hard from infiltration that they cannot be moved. In bad cases the cornea soon becomes hazy, and then rapidly opaque, from strangulation of its nutrient blood-vessels and lymphatics by the great pressure. In the adult the symptoms are all worse than in ophthalmia neonatorum, and in gonorrhœal conjunctivitis the symptoms are more intense and the course of the disease much more rapid and destructive than in the non-specific form.

The PROGNOSIS in all forms of the disease is unfavorable, but is much better in ophthalmia neonatorum than in the other forms. While it may be confined to one eye, it generally involves both. The great danger is suppuration of the cornea with consequent loss of sight.

TREATMENT.—In ophthalmia neonatorum cold applications should be made by cloths soaked in cold water and laid upon the closed lids, and frequently changed. Frequent irrigation of the culs-de-sac with cold bichloride solution (1 : 10,000) or cold boric-acid solution, and the application of a solution of silver nitrate to the everted lids (gr. i–v to the ounce), several times daily, are indicated.

In the purulent conjunctivitis of older children or of adults the application of cold through the medium of iced cloths, laid upon a block of ice and then applied to the lids and changed once a minute, should be insisted upon, and the irrigation of the culs-de-sac should be increased in frequency according to the amount of secretion. If the lids are very hard and tense, it may be necessary to perform canthotomy by dividing the external canthus with a strong pair of blunt-pointed scissors, and the severing of the external canthal ligament, so as to diminish the pressure on the eyeball. As soon as the lids can be everted they must be cauterized with a strong solution of silver nitrate (gr. x–xj), until the discharge ceases or becomes thin and ichorous, when it may be discontinued.

FIG. 426.
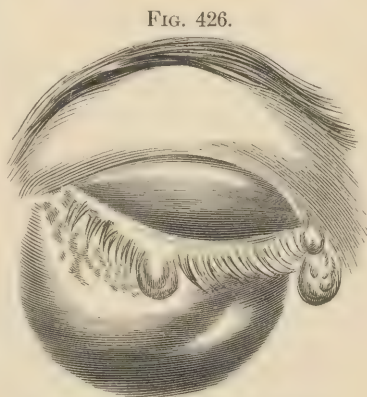
Ophthalmia neonatorum (Dalrymple).

Diphtheritic Conjunctivitis.—Though the disease sometimes occurs alone, it is usually connected with diphtheritic inflammation in the nose and fauces. The external symptoms resemble those of purulent conjunctivitis, except that there is more marked infiltration of the tissues of the lids and much less secretion until the purulent stage is reached. If the lids can be everted, there is no distinct membrane visible, but the conjunctiva and tarsus seem enormously thickened, present a bloodless appearance, and look like brawn, and the same condition exists in the ocular conjunctiva. The cornea rapidly becomes opaque and necrotic. *In these cases* it is sometimes necessary to discontinue the cold applications and *resort to hot fomentations* in order to hasten the suppurative stage, and thus, if possible, save the cornea by a reopening of the nutrient blood-vessels.

When the suppurative stage has been reached the TREATMENT is the same in all respects as for purulent conjunctivitis.

The PROGNOSIS is always unfavorable, most of the eyes so affected being lost through destruction of the cornea.

Granular Conjunctivitis, or Trachoma.—This is a chronic inflammation of the conjunctiva which originates by infection and produces an infectious purulent secretion. The conjunctiva becomes very much thickened, the papillæ hypertrophied, and a peculiar kind of granule is developed, mainly in the tarsal conjunctiva, but also in the fornix and occasionally in the ocular conjunctiva. It is one of the most frequent forms of eye disease which the surgeon is called upon to treat. It exists in two forms. The first form consists in the development of *papillæ* on the surface of the conjunctiva tarsi, without at first any thickening of the conjunctiva. The second form is characterized by the presence of the *trachoma granules*, which are gray or yellow, translucent, round bodies beneath the conjunctiva. They are sometimes distinctly gelatinous, and have received the name of "frog-spawn" granulations, or "sago grains." They are found mainly in the fornix or retrotarsal fold, and are sometimes arranged in longitudinal rows. These two forms sometimes occur separately, but are more often found together.

Fig. 427.

Conjunctiva of upper lid in chronic granular conjunctivitis (Arlt).

SYMPTOMS.—These are photophobia, lachrymation, impaired vision, and a sticking together of the edges of the lids, dependent upon the amount of secretion. If the case be an old one, there are either ulcers of the cornea or a condition known as pannus, which is a superficial keratitis, with or without the development of blood-vessels on the cornea, with hypertrophy of the epithelial layers, and opacity of the whole surface.

The SEQUELÆ of trachoma are trichiasis or distichiasis, which is a faulty arrangement of the cilia; entropion, posterior symblepharon, xerosis of the conjunctiva, and opacities of the cornea (Fig. 428).

Fig. 428.
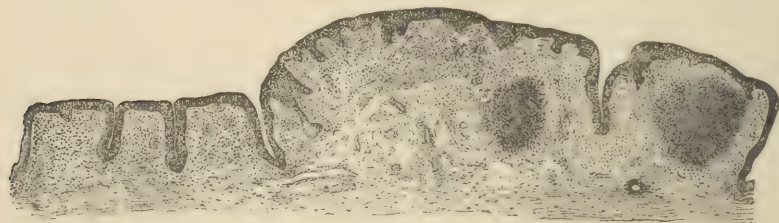
Section of conjunctiva in granular conjunctivitis (Fuchs).

TREATMENT.—During the last few years attempts have been made to shorten the duration of the treatment of this most chronic disease by various surgical procedures. Of these it is only necessary to mention one, the so-called method of *expression*. This consists in gently scarifying the conjunctiva over the masses of trachoma granules, and then holding the everted lid firmly by one end, applying Noyes' forceps or

Knapp's roller forceps to the opened follicles, and by compression squeezing out the contents of these follicles from one end of the lid to the other. As soon as one row is emptied the forceps should be applied to another row, and this should be kept up until all the follicles have been emptied of their contents. The cul-de-sac and lids are then washed clean with a bichloride solution (1 : 5000) and cold dressings applied, which must be frequently removed. The conjunctival surface is subsequently treated with astringent solution or by touching it with alum or sulphate of copper in crystal as long as any roughness or secretion appears.

The apparent advantage of this treatment over the old daily cauterization of the granulations appears to lie in shortening the duration of the disease. But experience has taught us that every process for directly destroying the granulations renders the shrinking of the conjunctiva only so much the greater, and the occurrence of the unfortunate sequelæ in the lids the more pronounced. Many surgeons therefore prefer to cauterize the granulations daily with a crystal of sulphate of copper or with strong solutions of nitrate of silver (gr. xx to xl), and apply cold applications for an hour to the closed lids; and this treatment is to be continued with modifications until the granulations have disappeared.

PTERYGIUM.

A **pterygium** is a triangular thickening or hypertrophy of a fold of the ocular conjunctiva, which grows from the inner or outer canthus toward the cornea and extends for a varying distance upon the cornea. The apex of the triangle is on the cornea and the base toward the canthus. It may be very thin and delicate, containing but few blood-vessels, and is then known as *pterygium tenue*, or it may be thick, opaque, and vascular, and is then termed *pterygium crassum*, both forms being simply different stages of the same growth (Fig. 429).

Its name is derived from the supposed resemblance in shape and texture to the wing of a small insect. It is most frequently found on the nasal side of the cornea, and it is occasionally met with on both sides of the cornea in the same eye. The apex of the growth is usually rounded and firmly adherent to the cornea, and the fan-like base spreads out and becomes merged with the conjunctiva, while when on the nasal side the plica semilunaris is entirely lost in the growth. Beyond the limbus the edges of the pterygium are rounded and not so adherent to the subconjunctival tissue, and a probe may be pushed beneath them for some distance (Fig. 430).

A pterygium grows very slowly, with or without symptoms of irritation, toward the centre of the cornea, which it only reaches in exceptional cases. It may remain stationary for years, being at times subject to inflammatory attacks. If it remain stationary, it grows thinner and lighter in color from disappearance of its vessels, and may eventually be converted into a thin, tendinous membrane. It produces no injurious results until its apex begins to involve the pupillary area of the cornea, when the vision becomes affected, and the visual defect increases in proportion as the apex of the growth approaches the centre of the cornea. An additional annoyance produced by a pterygium which has become attached to the cornea is a certain limitation of mobility of the eyeball in the opposite direction, owing to the restraining fibres of the growth. The pterygium is covered by the conjunctival and corneal epithelium, which is markedly hypertrophied, and on reaching the cornea the growth extends beneath the

epithelium into the parenchyma of the cornea. Hence it is wise to remove a pterygium before it encroaches far upon the cornea, as it always leaves an opacity beneath it, which interferes with vision.

FIG. 429.
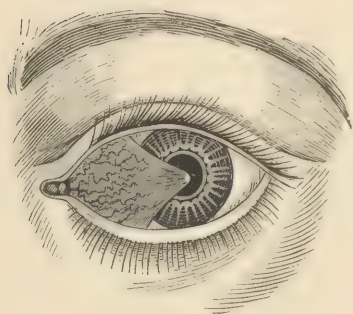
Pterygium (Guthrie).

FIG. 430.
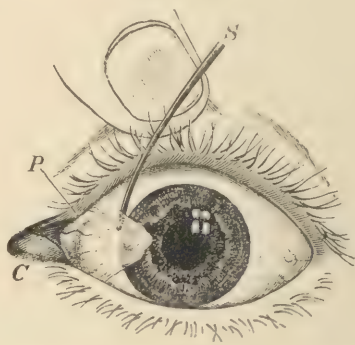
Passage of a probe beneath a pterygium (Fuchs).

ETIOLOGY.—A pterygium grows from the degenerative process existing in a pinguicula, makes its way into and on the cornea, and draws the conjunctiva after it. This degeneration can generally be seen at the apex as a narrow gray, hazy zone which forms its anterior border and which is sharply defined from the clear cornea. This accounts for the pterygium being met with in a line with the palpebral fissure, where the conjunctiva is more exposed to external injuries, influences of temperature or weather or occupation, such as wind, dust, foul or irritating atmosphere, etc. Microscopical examination of the apex of a growing pterygium shows a corrugation, and in places destruction of Bowman's membrane and a cell-infiltration of the cornea beneath it. Small cavities are sometimes found here lined with endothelium, in which cocci have been met with. Histologically, a pterygium is identical with the ocular conjunctiva, and consists mainly of fibrillar connective tissue covered by epithelium. Bowman's membrane is destroyed and the superficial lamellæ of the cornea are replaced by the tissue of the pterygium. This explains why the cornea does not regain its transparency after the removal of a pterygium. The growth may occur at any age, but is usually met with beyond middle life.

TREATMENT.—Several operations have been recommended for its relief, of which only two need be mentioned—viz. *excision* and *transplantation*.

Excision is to be preferred in all cases in which the pterygium is narrow and not very thick, and the operation may be done under local cocaine anæsthesia. The eyelids must be held open by a spring speculum, and the cul-de-sac and cornea thoroughly irrigated by a solution of bichloride of mercury (1 : 5000). The apex of the growth is seized with toothed forceps and carefully dissected off from the cornea with a small scalpel or a Beer's cataract-knife. This dissection is to be carried some little distance beyond the corneal margin, keeping the knife closely in contact with the cornea and sclera. The knife is then laid aside and two converging incisions are to be made with blunt-pointed scissors, one from the lower border of the pterygium and one from the upper border, which should meet at a point a varying distance from the corneal margin according to the size of the

pterygium. This removes the growth and leaves an irregular, rhomboid-shaped space on the eyeball. The whole surface of the wound should then be cleansed and the corneal wound scraped. The adjacent ocular conjunctiva above and below the wound should be loosed from the underlying sclera, and then the lips of the conjunctival wound should be closed with two or three fine sutures. Wet dressings and a bandage are then applied for twenty-four hours. This operation is applicable in almost all cases, and should be done early before the growth has encroached much on the cornea.

Transplantation of a pterygium is an operation but rarely needed, and should only be done when the growth is very broad and thick. The operation to be recommended is Knapp's modification of Desmarres' method. The corneal apex of the pterygium is to be dissected off in the way already described, and then two curved incisions are made, running from the upper and lower borders of the base of the pterygium toward the corresponding retrotarsal fold. The corneal part of the growth is then excised, and the remaining portion is divided by a horizontal incision. A small square flap of conjunctiva is then dissected off from the subjacent tissue above and below the wound, so as to cover the latter. The contraction thus produced causes the curved incisions to gape sufficiently to receive the horizontal halves of the pterygium, which are to be fastened in these incisions by sutures. The conjunctival flaps must then also be united by sutures. Simple cold dressings and a bandage are then to be applied for twenty-four hours.

Phlyctenular conjunctivitis appears in the ocular conjunctiva in the form of one or several eruptive vesicles along the corneal limbus or in the free conjunctiva. The eruption may be dull red with smooth elevation, but the epithelium is soon cast off and an ulcer appears. Each point of eruption has usually its own area of congestion. These vesicles may be accompanied by a general catarrhal conjunctivitis, and this determines the amount of the secretion.

The SYMPTOMS are slight smarting, lachrymation, mucous secretion, and spasmodic closure of the lids. The duration is from three days to two or more weeks. The disease is usually associated with bad hygienic surroundings, a scrofulous taint, and generally feeble health. It is much more common among children than adults. It is best treated with warm applications, a boric-acid lotion, a very weak ointment of the yellow precipitate of mercury (gr. $\frac{1}{2}$: ℥j), or finely powdered calomel dashed into the eye.

Herpes zoster ophthalmicus is a neuropathic affection having its cause in a degeneration of the ganglion of Gasser or of the branches of the trigeminus, or both. Any of the branches of the trifacial nerve may be affected, and the vesicular eruption appears in the course of distribution of the diseased nerve-filaments. These vesicles appear on the conjunctiva and cornea, as well as on the eyelids, surrounded by a zone of injection, and the inflammatory action may be so severe as to cause not only ulceration of the cornea, but iritis. It is confined to one side, and the SYMPTOMS consist, in addition to the appearance of the vesicles, of intense pain in the course of the affected nerve-twigs; redness, swelling, and sensitiveness of the skin of the cheek, lids, and forehead, resembling erysipelas; slight conjunctival discharge; and great photophobia and lachrymation. The pain sometimes ceases when the vesicles have ruptured. The disease may occur at any age, and is apt to be associated with a low condition of the system.

The TREATMENT consists in making continuous hot fomentations to the parts, the instillation frequently of a few drops of a solution of atropiæ sulphat. gr. ij, and cocaine hydrochlor. gr. x in the ounce of water, and the administration of full doses of morphia and quinine three times

a day. The ulcers sometimes leave permanent scars, and the disease has been known to produce destructive irido-choroiditis and atrophy of the optic nerve.

Pemphigus of the conjunctiva is a very rare disease, and may exist independently of the disease in other parts of the body. The affection is characterized by the rapid development of several large vesicles or bullæ in the ocular or palpebral conjunctiva, which contain a turbid serum, accompanied by a sharp attack of general conjunctivitis, lachrymation, and photophobia. When these bullæ burst there is left a raw, excoriated surface, which secretes a thick muco-purulent discharge. These raw surfaces frequently give rise to symblepharon.

TREATMENT is of little or no avail, for in the cases in which symblepharon does not result the tendency of the disease is to complete destruction of the mucous membrane and the formation of the condition known as xerophthalmia : cold applications, weak boric-acid solutions, and the free use of fatty substances make the patient more comfortable.

Xerophthalmia, or xerosis conjunctivæ, is an extreme degeneration and atrophy of the conjunctiva, and is caused by trachoma or pemphigus in the advanced stages, and is the condition existing in complete symblepharon. The mucous membrane is absolutely dry, very much thickened, of a dusky-red color, and its surface is rough and scaly. The cul-de-sac is wanting, the cornea is opaque and roughened, and the cilia are usually absent from atrophy of the hair-bulb.

All TREATMENT is useless, but the patients may have their condition palliated by the employment of emollients.

Morbid Growths in the Conjunctiva.—Syphilitic lesions of the conjunctiva include *chancre, mucous patches*, and circumscribed or diffuse *gummata*. Chancre and mucous patches occur most frequently in the palpebral conjunctiva, and usually involve the edge of the lid, though the latter have been met with in the ocular conjunctiva. The gummata are found in both the ocular and the palpebral conjunctiva, and if diffuse are apt to involve the whole thickness of the lid. The preauricular lymphatic nodes are generally involved. The chancre presents the usual appearance of a primary sore, but owing to its location has often been mistaken for an epithelioma. With regard to the mucous patch and gumma we are assisted in our diagnosis by other constitutional symptoms and by the history of the case. These lesions require no surgical interference, and must be treated constitutionally and locally in the usual way.

Tubercular disease of the conjunctiva appears as an open grayish ulcer from which nodules arise either within its area or on its margin, and is generally found in the palpebral conjunctiva. The lesion consists mainly of giant cells in which are found the bacilli.

Lupus presents very much the same appearance, except that it involves the skin at the edge of the lid as well. In both lupus and tubercular disease the lymphatic nodes in the vicinity are apt to be swollen. If the eyeball be not involved, thorough excision of both these morbid growths is promptly indicated. If the eyeball be invaded, enucleation and exenteration of the orbit is the only chance for the patient.

Polypi and **papillomata** resemble similar growths on other mucous membranes. They must be carefully excised and their bases cauterized.

Primary angeioma of the conjunctiva is a rare disease, the growth usually originating in the lid. It is a congenital affection, and is to be treated in the same way as angeioma of the lid or orbit.

The *cystic tumors* occasionally met with in the conjunctiva generally originate in dilated lymphatics or in pre-existing glands. Large cysts beneath the conjunctiva are formed by the cysticercus cellulosæ. Their contents are usually a pellucid fluid. Where possible they should be carefully dissected out with the cyst-wall intact.

Lipomata occur beneath the conjunctiva of the fornix or of the eyeball, and are generally situated near the outer canthus. They are congenital, yellow in color, and soft in consistency, and, if desired by the patient, are very easily removed.

Amyloid disease of the conjunctiva is not a true tumor, but a diffuse infiltration and degeneration of the conjunctiva and subconjunctival tissue. It grows very slowly, and rarely involves the ocular conjunctiva. The PROGNOSIS is good, and the only TREATMENT is complete extirpation. A small section cut from such a growth readily shows the distinguishing reaction to iodine and sulphuric acid.

Dermoid tumors are flat or rounded growths of solid consistence on the eyeball, situated partly in the ocular conjunctiva and partly in the cornea, and they are very intimately connected with the cornea.

Dermoid of cornea (Bull).

They are white or yellowish-white in color, covered by epidermis and occasionally by long hairs, and resemble closely in structure the true skin. They are always congenital, and are sometimes associated with coloboma of the eyelid. They arise either from a fœtal invagination of the external germ-layer or a circumscribed adhesion between the amnion and the surface of the eyeball. They are easily removed by excision with a sharp Beer's knife, carefully dissecting the growth from the cornea and sclera, and covering the wound by drawing the conjunctiva over it (Figs. 431–433).

Fig. 433.
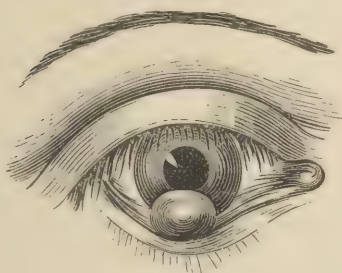
Fig. 432.
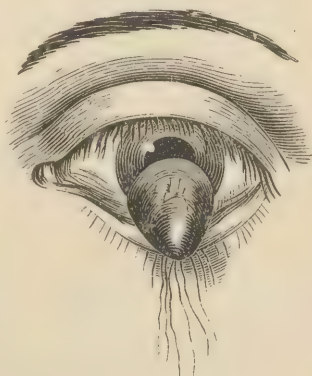
Dermoid tumors of conjunctiva and cornea (Bull).

Epithelioma originating in the conjunctiva is almost always found at the limbus. It forms a non-pigmented, flat, sessile tumor with a broad base, usually situated on the nasal or temporal side of the cornea. It remains for a long time confined to the superficial layers of the conjunctiva and cornea, and shows a marked tendency to ulceration. If such a tumor be seen early and be found to be strictly superficial, it is possible to remove it entire, and then the wound should be thoroughly cauterized. If, however, it have grown extensively superficially or have involved the deeper tissues, the only thing to advise is an immediate enucleation and exenteration of the entire orbit.

Primary sarcoma of the conjunctiva also almost invariably begins in the limbus, and is here generally pigmented, because of the presence of pigment in this region normally. A sarcoma grows more in height than in breadth, and has a relatively narrow base, so that it appears as a dark, prominent, mushroom-like growth which may cover a large part of the cornea. A sarcoma grows more rapidly than an epithelioma, sometimes attains an enormous size, and, except in the very beginning, always demands a most radical operation. In these cases of rapid growth the eyeball must be removed, even if the visual power be still fairly good. Sarcoma is more apt to involve the eyeball than epithelioma, and is much more likely to return in the orbital tissue.

Fibromata and *osteomata* are of extreme rarity in the conjunctiva. They are annoying from their size and weight, and should early be removed. They show no tendency to return.

Symblepharon.

Symblepharon is a cicatricial adhesion between the conjunctiva of the eyelids and the conjunctiva of the eyeball, and occasionally the cornea. This may be partial or complete—that is, it may extend from the ciliary margin of the lid to the cul-de-sac, and from one end of the lid to the other—or the adhesion may consist of one or more bands, more or less tendinous in appearance, running from the lid to the eyeball. These sometimes admit of a probe being passed beneath them. If the adhesions be complete between one or both lids and the eyeball, and extend to the cul-de-sac, the case cannot be cured by operative interference, and should either be left untouched or the eyeball should be removed and the orbital cavity closed by stitching the lids together.

ETIOLOGY.—Any circumstance which can give rise to the formation of raw surfaces on the palpebral and ocular conjunctivæ will cause symblepharon. Hence the most frequent causes are burns by the action of heat or molten metal or caustic substances. A symblepharon may also be caused by operations, by ulcers of all kinds, and even by diphtheritic conjunctivitis.

The contraction of the conjunctiva which occurs as a result of its gradual shrinking, which is so often seen after granular lids or trachoma, is not a true symblepharon, because there is no adhesion between two raw surfaces, but is rather a narrowing of the cul-de-sac. In advanced cases of this nature the fornix ceases to exist, and the conjunctiva of the lids extends directly to the eyeball. Such cases do not admit of operative interference.

TREATMENT.—If the adhesion between the lid and the eyeball consist of a single tendinous band, reaching from the lid to the globe and usually involving the corneal margin, Arlt's operation generally gives satisfactory results. The tip of the attachment to the eyeball is grasped with toothed forceps, and the band is dissected away from the globe as far as the cul-de-sac, leaving a raw surface on the ball. A suture armed with two needles is then passed through the free end of the frænum, and the needles are then pushed through the cul-de-sac to the surface of the skin, the ligature is drawn tight, and the two ends are tied over a bit of plaster or rubber tubing. This brings the epithelial surface of the frænum next the raw surface of the eyeball. This raw surface is next covered over by dissecting up and bringing down flaps of conjunctiva

from either side. A glass shell may then be inserted and worn over the eye, so as to aid in preventing undue contraction.

If the symblepharon be more extensive, this operation will not suffice, and resort must be had to one of the many plastic operations devised by Teale, Knapp, and others. In every case the adhesive bands are to be dissected free from the eyeball as far as the fornix, and the raw surface on the eyeball is then to be covered, leaving that on the lid to take care of itself.

Fig. 434.

Teale's operation consists as follows (Figs. 434, 435, and 436): An incision is to be made through the adherent lid in a line corresponding to the margin of the concealed cornea, and the lid is then to be dissected from the eye as far as the fornix (Fig. 434). Two flaps of conjunctiva are then formed—one from the surface of the globe near the inner extremity of the raw surface, the other from the surface of the globe near the outer extremity, the apex of each passing toward the upper surface of the eyeball (*B* and *C*, Fig. 435). These flaps are carefully dissected from the globe until they are free enough to stretch across the chasm without great tension, care being taken to leave a sufficient thickness of tissue near their bases. The two flaps thus made are then adjusted in their new situation (Fig. 436). The inner flap, *B*, is stretched across the raw surface of the eyelid, while the outer flap, *C*, is
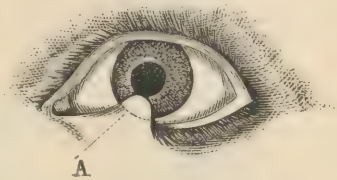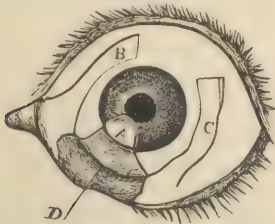
Fig. 435.   Fig. 436.
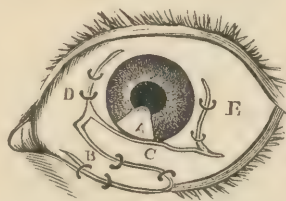
Teale's operation for symblepharon.

made to cover the raw surface of the eyeball, and both are stitched to healthy conjunctiva at their apices; and thus the two flaps are dovetailed into the wound. The margins of the gaps whence the flaps were taken are sutured. The apex of tissue left attached to the cornea soon atrophies.

The transplantation without pedicle of pieces of healthy conjunctiva from the human eye or from the rabbit's eye, or of the buccal mucous membrane, to cover the raw surface on the eyeball made by the detachment of the adhesive bands, is another method employed for the cure of symblepharon which sometimes gives satisfactory results in bad cases. Wolfe of Glasgow was the first to recommend this method.

Ankyloblepharon is a more or less extensive cicatricial adhesion of the edges of the eyelids to each other. It may be either partial or total, and often coexists with symblepharon, the same injury having given rise to both these conditions. The effect of ankyloblepharon is to diminish the length of the palpebral fissure and hinder the movements of the lids.

ETIOLOGY.—The most frequent causes of ankyloblepharon are chemical and mechanical injuries, such as burns or scalds from hot fluids or molten metals, strong acids, etc. Blepharitis, accompanied by ulcerations at the edges of the lids, may produce it if the ulcers be opposite each other on the lids and if the eyes be kept closed for any length of time by a bandage.

TREATMENT.—Before operating for the relief of ankyloblepharon we must ascertain whether symblepharon also exists, and, if so, how extensive it is; for if the lid be adherent to the cornea, very little benefit can be expected from an operation. If the adhesion extend as far as either canthus, the edges of the lids must not only be separated, but the canthus must be covered by a lining of conjunctiva, or else the adhesion will form there again.

If a small opening exist at or near the canthus, and the adhesion be partial and confined to either angle, a probe should be passed through the opening under the lid to determine the presence of bands of adhesion to the eyeball (Fig. 437). A grooved director may then be passed through the hole and the adhesion between the lids carefully divided. If there be no symblepharon, a small strip of conjunctiva from the lid or cul-de-sac may then be transplanted to the edge of one of the lids and stitched in position, so as to cover it with an epithelial surface and prevent readhesion.

FIG. 437.

Relief of ankyloblepharon (Lawson).

When symblepharon is present with the ankyloblepharon, the extent of the former will enable us to decide whether an operation will be of any practical value. If the ankyloblepharon be total, no operation is justifiable, as extensive adhesions between lids and eyeball are always present and the cornea is seriously involved.

DISEASES OF THE LACHRYMAL APPARATUS.

The only *malformation*, so called, of the lachrymal gland of which we have any knowledge is rather a displacement or dislocation than a true malformation, and seems to be due to an undeveloped or relaxed condition of its enveloping capsule. In this condition the gland presents beneath the ocular conjunctiva over the insertion of the external rectus muscle, causing a visible protuberance and some interference with the mobility outward of the eyeball. If it produce great annoyance, the displaced gland may be removed through an incision in the conjunctiva.

Dacryo-adenitis, or inflammation of the lachrymal gland, may be acute or chronic in character. If the former, it rapidly develops into an abscess.

The SYMPTOMS consist in the appearance of a firm, nodulated, immovable swelling at the upper and outer angle of the orbit; redness and puffiness of the upper lid, causing the lid to droop; injection and chemosis of the conjunctiva; tenderness on pressure of the gland and neighboring orbital margin; dull pain; and possibly displacement of the eyeball downward and inward. The inflammation may develop rapidly into an abscess with all the signs of suppuration; the abscess points and discharges usually through the skin of the lid near the external canthus, though it may do so through the conjunctival cul-de-sac.

ETIOLOGY.—Dacryo-adenitis may be due to cold, to traumatism, to purulent conjunctivitis, to orbital cellulitis, or to periostitis of the orbit.

TREATMENT.—This consists in the use of hot fomentations and in free incisions into the swollen gland through the skin of the lid beneath the orbital margin or through the conjunctival cul-de-sac. If an abscess of the gland have perforated spontaneously through the lid, it may leave a permanent fistula. This should be treated by making and maintaining a free opening into the gland through the conjunctival fornix,

and then slitting up the fistulous tract on a grooved director and treating it as any other fistula.

Cystoid Disease of the Gland.—Cysts of the lachrymal gland are of rare occurrence.

The SYMPTOM of such a cyst is the appearance of a small, elastic swelling at the upper and outer angle of the upper lid. When the lid is everted the cyst appears as an elastic, fluctuating swelling, which increases rapidly in size if the patient weep or if the conjunctiva be irritated. It is due to the stoppage of one or more of the excretory ducts of the gland.

The TREATMENT should consist in making an artificial opening on the inside of the conjunctiva by removing a portion of the cyst-wall, so that the secretion may have free exit.

Tumors of the Lachrymal Gland.—Tumors or new growths originating in the lachrymal gland are of extremely rare occurrence. Almost all the cases hitherto reported have been instances of extension of the new growth from the connective tissue of the orbit or the periosteum to the gland. Cases have been reported of all the various pathological new growths occurring in the gland, the most frequent being sarcoma.

The SYMPTOMS are the same for all these neoplasms—pain and swelling in the orbit and upper lid and displacement and protrusion of the eyeball.

TREATMENT consists in extirpation of the lachrymal gland, which should be done as soon as possible after the nature of the disease has been recognized.

If the growth appear to have originated in the gland, the operation is done as follows: The lids are put on the stretch at the external canthus, and the commissure is divided by a horizontal incision from half an inch to an inch in length. The skin, muscle, and tarso-orbital fascia at the outer third of the lid are then to be divided by a curved incision just beneath the superior orbital margin, the outer end of which should join the outer end of the horizontal incision. This makes a triangular flap which is displaced inward, and an entrance into the orbit is thus made, and the gland is easily reached with a hook, pulled forward, carefully separated from its attachments, and removed. The wound should then be cleansed, and after all bleeding has ceased it should be closed by deep sutures, which should include the divided tarso-orbital fascia and the edge of the periosteum, so as to avoid the subsequent occurrence of ptosis.

THE LACHRYMAL CANALICULI, SAC, AND DUCT.

Malformations.—Among the malformations or congenital anomalies the most frequent are duplications of the puncta and canaliculi, and also their entire absence. In the case of the latter any attempt to create a natural passage for the tears into the lachrymal sac generally ends in failure.

The terms *epiphora* and *stillicidium lachrymarum* mean an overflow of tears upon the external surface of the lids and cheek from inability to find exit through the punctum and canaliculus to the lachrymal sac. This may be due to a congenital absence of the puncta or to their displacement by inversion or eversion of the lids from disease, or to traumatism, or to some obstruction in the nasal duct. In many cases this may be relieved or entirely cured by slitting up one or both canaliculi from the puncta to their opening in the lachrymal sac, which is done in the following way: The operator should stand behind the patient, using his right hand for the right eye of the patient, and the left hand for the left eye. A probe-pointed Weber's knife is then introduced vertically into the lower punctum, and immedi-

ately turned into the horizontal plane, with the edge directed upward and slightly backward toward the eye, and the knife is immediately pushed toward the median line until the point strikes the lachrymal bone. A probe may then be passed into the sac and down into the duct, and the presence of any obstruction at once detected. The incised canaliculus should be kept from closing by the daily passage of the probe until the cut edges have healed.

Dacryo-cystitis, or inflammation of the lachrymal sac, is of two kinds—*catarrhal* and *purulent*. The former is called *mucocele*, and always exists in connection with catarrh of the nose or conjunctiva, or both.

The SYMPTOMS begin with epiphora, followed by slight and occasional swelling in the region of the lachrymal sac, and slight oozing of a few drops of a turbid, viscid mucus, which is increased in amount by pressure over the sac. This catarrhal condition may exist for a long time without change, but sooner or later it develops into the purulent form, with all the symptoms intensified, and the discharge is purulent. When pressure on the sac succeeds in emptying it downward through the nose, there is no stricture ; but if the sac can only be emptied through the puncta, there is a stricture somewhere, and usually at the juncture of sac and duct. The purulent form may at any moment assume the type of acute phlegmonous inflammation and abscess, with severe pain, the appearance of a hard, tense tumor over the sac, which is acutely sensitive, great swelling of the lids and neighboring parts, with a red, glistening, tense condition of the skin, and in severe cases complete closure of the lids. This condition of phlegmonous inflammation, if left to itself, ends in ulcerating through the skin just below the level of the internal canthal ligament, and in the formation of a lachrymal fistula.

FIG. 438.

Abscess of lachrymal sac (Dalrymple).

ETIOLOGY.—Dacryo-cystitis is almost always caused by extension of disease from the nose, either a nasopharyngeal catarrh or a periostitis, with actual bone disease of the duct. More rarely it has been known

to arise from purulent conjunctivitis and from caries of the lachrymal bone and ethmoid labyrinth.

TREATMENT.—Our efforts should be directed toward preventing the onset of the phlegmonous attack. When the condition is that of muco-cele, one or both canaliculi should be incised, the sac emptied of its contents and washed out, and a probe passed into the duct. If a stricture be present, it is found usually at the junction of the sac and duct, and must be divided.

The surgeon stands behind the patient and introduces a long probe-pointed Weber's knife, with malleable shaft, into the canaliculus, and pushes it along until its point is in contact with the lachrymal bone. Then, keeping the point pressed against the lachrymal bone, the handle is rapidly brought up to the perpendicular with the edge forward, and then driven straight down through sac, stricture, and duct to the floor of the nose. If the stricture be found to be tense and broad, this manœuvre must be repeated several times with the edge of the knife turned in different directions, so as to divide the stricture several times. Then a Theobald inflexible steel probe of large size (No. 12 or 14) should be passed, exactly as was the knife, to the bottom of the duct. If these directions be carefully followed, no false passage will be made (Fig. 439). The probe should be passed daily until the lips of the wound have become glazed over, and the sac and duct should be irrigated with an antiseptic astringent solution until all secretion has ceased.

If the case be one of phlegmonous dacryo-cystitis, our first efforts should be directed toward allaying the acute inflammation, which is done by the continuous

FIG. 439.
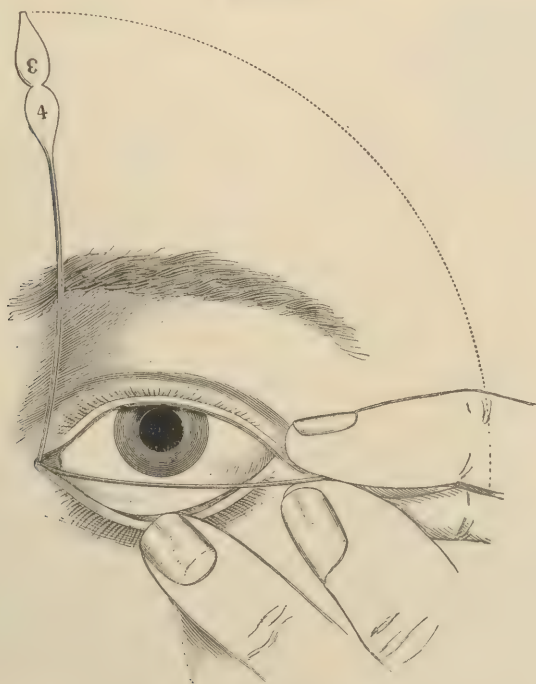
Method of inserting Bowman's probe (Norris and Oliver).

application of hot bichloride fomentations (1 : 5000), and the pain should be relieved by anodynes. If we succeed in doing this before the occurrence of a fistula, these cases do well. As soon as the acute swelling and tenderness have subsided and the

puncta can be seen, one or both canaliculi are to be incised, and the stricture is to be thoroughly divided as before directed. Then a thorough irrigation of the sac and duct through to the nose with hot bichloride solution should be done, and this should be followed by the passage of the steel probe as before. The irrigation and probing should be done daily for ten days or two weeks, and then at longer intervals, and the hot fomentations should be continued as long as any acute inflammatory symptoms remain.

DISEASES OF THE CORNEA.

The diseases of the cornea which require surgical interference would scarcely come under the care of a general surgeon. The ordinary forms of keratitis, ulcer, and abscess of the cornea do not come within the scope of this work, but a few brief remarks in regard to those affections of the cornea which demand the aid of the knife may not be out of place here.

Conical Cornea, or Keratoconus.—This is an alteration in the natural curvature of the cornea, so that it becomes conspicuously conical, without any alteration in its transparency. It is not an inflammatory process, but an atrophy of the corneal substance. The conicity may be more or less globular, and the apex of the cone may be central or more or less peripheral. The disease is generally met with in young people, is of slow progress, and sometimes is spontaneously arrested. There is

FIG. 440.

Conical cornea (Bull).

sometimes pain ; there may be marked symptoms of asthenopia; and the vision for all distances is much impaired and cannot be improved by glasses, because of the discomfort occasioned by them (Fig. 440). Various surgical procedures have been essayed either to improve the vision or to correct the deformity. *Iridectomy* and *iridodesis* have been recommended, the object being to displace the pupil toward the periphery, and then supplement it by tattooing the apex of the cone.
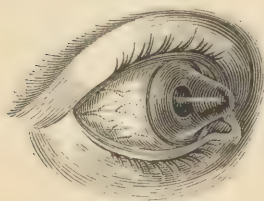
Bowman advised trephining the apex of the cone and removing a small disk of corneal tissue, leaving the opening to close by granulation, but this requires a subsequent iridectomy. Another method is to cauterize the apex with the actual or galvano-cautery, and repeat the burning until a suitable effect is gained. Perforation of the cornea and prolapse of the iris are apt to occur, and iridectomy will then become necessary. A simpler method is the excision of a small piece of cornea and the closing of the wound by very fine sutures.

FIG. 441.

Total staphyloma of cornea (Bull).

FIG. 442.

Total staphyloma of cornea (Sichel).

Staphyloma of the Cornea.—This deformity is usually the result of extensive ulceration and perforation of the cornea with prolapse of

the iris, and appears as an irregular conical or rounded protuberance which is more or less opaque. It may be either very vascular or entirely devoid of visible blood-vessels (Figs. 441, 442). The intra-ocular tension is usually increased.

The protrusion may be excised, and the large opening closed by introducing sutures through the ocular conjunctiva and drawing the latter over the hole in the eyeball, but the safer procedure is to enucleate the eyeball, especially if the patient be an adult, as sympathetic ophthalmia has been known not infrequently to follow excision of a corneal staphyloma.

Morbid Growths of the Cornea.—It is still doubtful whether tumors originate primarily in the cornea. We meet with fibroma, sarcoma, epithelioma, papilloma, and dermoid tumors. The latter are congenital, involve the limbus, and start from the conjunctiva, as does the epithelioma. Leprous nodules and tuberculous deposits have been reported as occurring in the cornea. The papillomata and the dermoid tumors may be excised and do not return, but in all cases of sarcoma and epithelioma the eyeball should be enucleated at once.

Iritis and Irido-cyclitis.

The anatomical connection between the iris and the ciliary body is so intimate that disease of the one is very apt to involve disease of the other. This is particularly true when iritis or cyclitis is due to some constitutional cause like syphilis or rheumatism, and also in the case of tumors. One of the most frequent mistakes in diagnosis made by the student and general practitioner is in confounding iritis with some other ocular disease, usually conjunctivitis; but if due attention be given to the symptoms of inflammation of the iris as here enumerated, such a mistake is not likely to occur.

Iritis is an inflammation of the iris, with infiltration of its tissue and more or less marked exudation upon the anterior and posterior surfaces of the iris, mainly the latter, and into the anterior chamber.

The SYMPTOMS which are usually present in all forms of iritis are as follows: Circumcorneal injection; haziness or turbidity of the aqueous humor; swelling, discoloration, and sluggishness or immobility of the iris; irregularity in shape or size of the pupil; impaired vision; photophobia; lachrymation; and pain.

The distinguishing point between iritis and conjunctivitis is the *circumcorneal* or *ciliary injection*. There are two very common varieties of ocular injection, which must be thoroughly differentiated so as to be recognized at a glance. The most frequent of these is the *conjunctival injection*, consisting of long, superficial, tortuous vessels, running from the fornix toward the cornea, which are indirectly branches of the external carotid. They are always present in conjunctivitis, and are darker in color than the vessels met with in the circumcorneal injection. The second injection is the *ciliary* or *circumcorneal*, consisting of short, deep, straight vessels, rarely more than one-sixteenth of an inch long, pink or scarlet in color, which form a more or less complete zone immediately around the corneal margin. They are branches indirectly of the internal carotid through the medium of the ciliary and ophthalmic arteries, and are present in *keratitis*, *iritis*, and *cyclitis*, but are *never* present in conjunctivitis.

The following points of differential diagnosis are very necessary to remember to enable us to distinguish between conjunctivitis, keratitis, and iritis. In conjunctivitis there is always injection of the inner surface of the eyelids, as well as of the ocular conjunctiva, and in the latter the injected vessels are superficial, long, and tortuous, and movable under the finger. There is usually some secretion of muco-pus and more or less swelling of the lids.

If the cornea be involved, besides the injection of the short, deep, straight vessels around the corneal margin there is either infiltration of the transparent cornea or loss of substance as in an ulcer, or both. There may also be loss of brilliancy of the corneal surface and the presence of a conjunctival injection.

If the iris be involved, besides the circumcorneal injection the other symptoms as previously given are present. In rare cases conjunctivitis and iritis coexist, and then we meet with the double injection.

Plastic iritis is the most frequent variety of iritis, and is always marked by the presence of the above symptoms. *Serous iritis* is only one form of the plastic variety, and its presence is usually indicated by the appearance of punctate, brownish deposits on the posterior surface of the cornea. The exudation in plastic iritis is mainly from the posterior surface of the iris, and this fibrinous exudation glues the iris to the capsule of the lens and causes the adhesions known as "posterior synechiæ," which account for the irregularity in the shape of the pupil and the more or less marked immobility of the iris.

If the plastic iritis be of the rheumatic or gouty variety, in addition to the usual symptoms a gelatinous or spongy deposit, highly fibrinous in character, is usually found in the anterior chamber, which in severe cases is apt to block the pupil and may even fill the anterior chamber. In this type of the disease the inflammation is not confined to the iris, but also involves the ciliary body and choroid.

Purulent iritis is a rare disease, and, when not due to traumatism, is usually of metastatic origin or extends to the iris from the inflamed choroid. When the purulent process is confined to the iris, it is almost always of traumatic origin from some perforating wound of cornea and iris. In addition to the general symptoms of iritis, we also find small abscesses in the iris tissue, and occasionally *hypopyon* or pus at the bottom of the anterior chamber (Fig. 443).

Gummatous iritis, or *gumma of the iris*, is by no means a rare affection, and is met with only in syphilitic patients. The term "syphilitic iritis" should be confined to this form of the disease, characterized by the presence of a gumma in the tissue of the iris, either at the sphincter margin or at the periphery, and presenting as a distinct yellowish elevation, which is usually vascularized from base to summit. In syphilitic patients the iritis present is generally of the plastic type, and differs in no respect from any other case of plastic iritis; but a gumma of the iris gives a distinctive character to the case, and hence the name "syphilitic iritis" should be confined to this type of the disease.

Fig. 443.

Iritis with hypopyon and chemosis of bulbar conjunctiva (Demours).

Tuberculous iritis comes more properly under the head of Tumors of the Iris, and will be there considered.

ETIOLOGY.—Iritis may be caused by long-continued cold, and even by long-continued exposure to the heat and glare of the sun, as in the tropics, and is then a purely local, idiopathic disorder. The other local causes are traumatism and sympathetic inflammation. By far the most common cause is some general constitutional disease, and the most frequent of these is syphilis. Then follow, in the order of frequency, rheumatism, gout, acute infectious diseases, tuberculosis, and diabetes. In all of these cases the iritis is of the plastic type, except in tuberculosis and in true syphilitic iritis with the development of a gumma.

PROGNOSIS.—The prognosis is generally very good, except in bad cases of rheumatic iritis and in tuberculous iritis. In the latter form the case ends in more or less marked destruction of the eye.

TREATMENT.—This is divided into local and constitutional. Hot fomentations or dry heat should be employed to allay the inflammatory process and to promote absorption of the plastic exudation. Atropine should be instilled into the eye to dilate the iris and break up the posterior synechiæ, and, secondarily, to allay pain. The strength of the solution should vary from one grain to four grains to the ounce, or even stronger, according to the severity of the attack, and the latter should also regulate the frequency of the instillations. If there be severe pain, this may often be allayed by applying cups or leeches to the temple. The eye should be protected from the light by dark glasses or a shade, but never by a bandage, and the room in which the patient remains should be moderately darkened.

The *constitutional treatment* should vary with the cause of the disease. If it be syphilis, the treatment by mercurials and potassium iodide should be pushed rapidly to toleration, in order to forestall dense adhesions or the development of gummata. If rheumatism or gout be the cause, the patient must be brought as rapidly as possible under the influence of sodium salicylate, salicylic acid, or salol, in order, if possible, to prevent the spread of the disease to the choroid; for if the latter become involved, the vision is usually permanently impaired. There is no special treatment indicated for iritis due to diabetes or tuberculosis or the acute infectious diseases. The local treatment is the same for all varieties of iritis.

The *surgical treatment* for the results of iritis or irido-choroiditis comes within the domain of the ophthalmic surgeon only, and should properly be left to him. The operations to be advised consist of *iridectomy* or *iridotomy.* In some rare cases enucleation of the eye becomes necessary as a prophylactic against sympathetic ophthalmia.

GLAUCOMA.

Glaucoma is the term applied to a morbid condition or variety of conditions of the eyeball, characterized by increased intraocular tension or hardness of the globe. It may be either primary or secondary, inflammatory or non-inflammatory, acute, subacute, or chronic.

SYMPTOMS.—The following symptoms are common to the disease, though they are not all constantly present in each variety: (1) Increased *intraocular tension;* (2) change in the *size and shape of the pupil* and in the appearance and mobility of the iris; (3) *loss of transparency in the cornea;* (4) *change in the depth of the anterior chamber;* (5) *turbidity of the aqueous and vitreous humors;* (6) *engorgement* and tortuosity of the conjunctival and episcleral vessels; (7) *excavation* or cupping of the *optic disk* of the "overhung" variety and the surrounding "glaucomatous ring;" (8) *pulsation of the veins,* and sometimes of the arteries,

on the optic disk; (9) *pain*; (10) *anæsthesia of the cornea*; (11) *diminution of central vision*; (12) *loss of accommodation*; (13) *narrowing of the field of vision*, generally of the concentric variety, and most marked on the nasal side; (14) *iridescent vision*, or seeing colored halos around artificial lights.

These symptoms, or such of them as are present, are always most marked in the acute inflammatory type of the disease.

Chronic or *simple, non-inflammatory* glaucoma is the most frequent type of the disease.

CAUSES.—Glaucoma is rarely met with before middle life. The refraction of a glaucomatous eye is generally hypermetropic, and very frequently astigmatic. In eyes predisposed to this disease an attack may be excited by mental worry, overwork of the eyes without glasses or with improper glasses, heart disease, and any disturbance of the vascular system. Many theories have been advanced to explain the mechanism of an attack of glaucoma, no one of which is entirely satisfactory.

PROGNOSIS.—The disease tends naturally, if unchecked, to absolute blindness, and hence the prognosis is unfavorable, though it depends on the type of the disease and the stage of development. The prognosis is most favorable in acute inflammatory glaucoma, and least so in simple chronic glaucoma.

TREATMENT.—No satisfactory result is ever gained except by operation.

Eserine sulphate, in a solution of one-quarter to one-half a grain strength, will sometimes relieve the symptoms or postpone temporarily the advance of the disease, and may always be used if an operation be not possible. But the only method of treatment which offers any hope of success is an operation to relieve the increased intraocular tension, and this may be either an iridectomy or a sclerotomy according to the nature of the case. This disease must be relegated to the domain of the ophthalmic surgeon, who alone is best fitted to cope with its difficulties.

SYMPATHETIC OPHTHALMIA.

Sympathetic ophthalmia is the term applied to those affections of the eye, and mainly of the internal structures, which result from injury to or disease of the fellow-eye. It presents itself under two distinct forms, one of which is called *sympathetic irritation*, and the other *sympathetic inflammation*; and they are two essentially different conditions.

Sympathetic irritation is a neurosis or functional disturbance characterized by photophobia, lachrymation, blepharospasm, impaired accommodation, subnormal vision, supraorbital neuralgia, photopsic manifestations, sometimes narrowing of the visual field, and an inability to continue close work. Any or all of these symptoms may be present in the uninjured or sound eye. During the occurrence of these symptoms in the second stage the injured or diseased eye is usually injected about the ciliary region, and there are photophobia, tenderness on pressure, ciliary neuralgia, and sensitiveness to light. These symptoms in both eyes may subside, only to recur again and again.

Sympathetic inflammation is an ophthalmitis, usually confined to the uveal tract—*i. e.* the iris, ciliary body, and choroid—though it may involve the nerve and retina, either alone or in connection with the uveitis. More rarely it involves the conjunctiva or cornea, or both.

It is characterized by pain, photophobia, lachrymation, circumcorneal injection, exudation into the aqueous or vitreous humors, punctate deposits on the posterior surface of the cornea, iritis, exudation into the field of the pupil, cataract, increased tension, narrowing of the anterior chamber, extreme sensitiveness on pressure, and loss of sight. These symptoms may end in subnormal tension and atrophy of the whole eyeball. Sometimes the first intraocular symptoms are those of neuro-retinitis before the uveal tract has become involved. These symptoms may be acute or chronic.

ETIOLOGY AND PATHOGENESIS.—According to the most recent investigations, all the nerve-structures of the diseased or injured eye may assist in the transmission of the trouble to the fellow-eye. The causes may be as follows: (1) *Foreign bodies* in the eye; (2) punctured, incised, or lacerated *wounds of the ciliary region;* (3) *wounds or ulcers of the cornea,* with incarceration or prolapse of the iris; (4) *operations on the eyeball,* such as discission, iridectomy, iridodesis, extraction of cataract, and anterior sclerotomy; (5) *traumatic cataract and dislocation of the lens;* (6) *ossification* of the *choroid* and ciliary body; (7) *intraocular tumors;* (8) incarceration of the ciliary nerves and stump of the optic nerve in cicatricial tissue, after enucleation; (9) more rarely, pressure of an artificial eye upon the stump.

The period of time between the receipt of the injury or the onset of the disease in the first eye, and the development of sympathetic trouble in the fellow-eye, varies within wide limits, from forty-eight hours to many years, but the disease usually develops within the first three months. The term "sympathetic" was first applied to this disease because it was originally thought that it was due to a reflex action through the ciliary nerves. Of recent years this theory has been abandoned by many for the theory "by infection," in which the course of the micro-organisms is through the medium of the sheaths of the optic nerves, the possibility of which has been demonstrated by Deutschmann. Hence the name "migratory ophthalmitis" has been proposed for this disease.

PROGNOSIS.—The prognosis of sympathetic ophthalmia is always unfavorable, especially if the uveal tract have been involved. If the sympathetic inflammation be of the nature of a simple serous iritis or a neuro-retinitis, without participation of the ciliary body or choroid, it may be possible to promise a partial recovery of vision. It is much more favorable if treatment be undertaken during the stage of *sympathetic irritation.*

TREATMENT.—This varies according to the existing stage of the affection in the second eye. If the condition of the second eye be that of *sympathetic irritation only,* without any signs of *sympathetic inflammation,* prompt enucleation of that injured or primarily diseased will, in the great majority of cases, prevent the occurrence of sympathetic ophthalmia in the second eye. If, however, *sympathetic inflammation* have already begun, enucleation should not be done if there be any vision in the first eye, for the operation will have no effect upon the diseased process in the second eye, and very often the resulting vision in the injured eye will be better than that in the eye secondarily affected.

No operation, such as iridectomy or sclerotomy, on the sympathetically inflamed eye ever brings about any favorable result upon the course of the inflammatory process. The surgeon should wait until all inflam-

matory symptoms have subsided before attempting any surgical interference.

In sympathetic *ophthalmitis* the patient should be kept in a darkened room. Leeches should be applied to the temples as often as may be necessary, and atropine and cocaine in the same solution should be instilled frequently unless there be marked increase of the tension. Tonics and alteratives should be administered, and small doses of mercurials if the health of the patient admit. If the patient suffer from confinement, his eyes should be bandaged, and moderate exercise in the open air be prescribed daily.

In place of enucleation it has been proposed to perform either *optico-ciliary neurotomy* or *neurectomy*. The first of these consists in dividing the optic and ciliary nerves behind the eye, leaving the globe *in situ*. The second consists in excising a portion of the optic and ciliary nerves behind the eye, also leaving the globe intact in the orbit.

The first of these methods, the neurotomy, may be rejected, as sympathetic inflammation has been known to extend to the fellow-eye after such a neurotomy, the divided ends of the nerves being left more or less closely in apposition. The second operation, neurectomy, has been known to serve its purpose, though sometimes followed by profuse hemorrhage behind the eyeball.

The following *indications* may be laid down for the *enucleation of the first eye* before the outbreak of sympathetic inflammation in the fellow-eye :

(1) When the wound is in the ciliary region, and is so extensive as to greatly damage or entirely destroy the vision ;

(2) When the wound is in the ciliary region, and is already accompanied by iritis and cyclitis;

(3) When the eye contains a foreign body, and all attempts at its removal have proved futile ;

(4) When the eye is shrunken and atrophied, and tender on pressure or continually irritated.

Cataract.

The name **cataract** is applied to an *opacity of the crystalline lens or its capsule* and may be either partial or complete. Its causes may be either local or constitutional. It may be *stationary* or *progressive ; ripe* or *unripe ; soft, hard,* or *hypermature ; simple* or *complicated ; traumatic, idiopathic,* or *congenital.*

The opacity may begin at the periphery or in the nucleus of the lens, or in both regions at once. Senile cataract generally begins at the periphery and extends toward the centre, and until it encroaches on the field of the pupil is not recognizable except by the skilled ophthalmic surgeon.

The one subjective SYMPTOM *is a slow and progressive failure of vision.* If, on examining the eyes of such a patient the pupil be found to be of a gray or whitish color, instead of black, and the opacity to be distinctly behind the plane of the iris, the trouble is either in the lens or in the anterior layers of the vitreous humor, and by dilating the iris with some mydriatic it can be determined exactly where the opacity is situated. Dense opacities in the vitreous humor are rarely so far forward as to give a white reflex from the pupil. If, on the contrary, the gray or whitish opacity be in front of the plane of the iris, it must be either in

the cornea or in the anterior chamber, and a closer inspection with oblique illumination will determine its location.

Sometimes an intraocular tumor growing from the retina or choroid has by the unskilled been mistaken for a cataract. But usually these tumors show a network of blood-vessels running over them, which never exist in a cataract.

A senile cataract usually occurs in both eyes, though it may be farther advanced in one eye than in the other. Soft cataracts may be unilateral or bilateral, and, if not due to traumatism and not congenital, are symptomatic of some general systemic disorder, or due to some previous inflammatory process in the deeper parts of the eye. They occur not infrequently in diabetes, more rarely in disease of the liver or kidneys, and have sometimes been met with as a sequel of the continued fevers. In such cases they are the *result* of malnutrition of the lens.

There are *many varieties of cataract* which are of interest solely to the ophthalmologist. The tendency of all cataracts is to increase slowly until the whole lens is involved, but to this rule there are exceptions. In myopic eyes lens opacities grow very slowly, and are often stationary for years. In rare cases the opacities of the lens have been known to diminish, and even to disappear, with corresponding improvement in the vision.

The PROGNOSIS as to vision is unfavorable unless an operation be done. The prognosis as to vision after operation is favorable, the great majority of patients recovering useful, and many of them very acute, vision.

TREATMENT.—In congenital cataracts and the soft cataracts of youth the best results are gained by *keratonyxis* or *discission*, which consists in the introduction of a needle through the cornea, lacerating the capsule and stirring up the lens-tissue, and then waiting for absorption to take place, trusting to the production of a more or less open pupillary space, through which the patient may see. In hard cataracts of all varieties in the adult the only operation which promises any satisfactory results is the *extraction of the lens.*

The operation of *extraction* may be either *simple* or *combined*, according to whether the lens be removed through the natural pupil without excising a piece of iris-tissue, or through an artificial pupil made by iridectomy. A full description of these operations will be found in any text-book on ophthalmology. No operation for the extraction of cataract should be done by any save an ophthalmic surgeon, and then only after the most careful investigations of the functions of the eye and the general health of the patient.

PANOPHTHALMITIS.

Panophthalmitis, or *phlegmonous inflammation of the eyeball,* is a somewhat complex process in which all the tissues of the eye become involved in the purulent process. While usually *traumatic* in origin from some laceration or rupture of the eyeball, the germs being probably introduced at the time of the injury, it frequently arises from *abscess of the cornea,* which perforates into the anterior chamber, or is due to the propagation of the purulent process from a *suppurative choroiditis,* which may be thrombotic or metastatic in origin.

SYMPTOMS.—The course of the disease is rapid and severe, and the symptoms resemble those of orbital cellulitis. The eyelids become red

and swollen; the conjunctiva is injected and chemotic, especially around the corneal margin. There may be a thin purulent discharge from the lids. If the cornea be clear, the aqueous is seen to be hazy, and there may be a deep yellow reflex from the fundus. The symptoms increase rapidly in severity: the cornea becomes infiltrated; the orbital tissue takes on a hard and brawny condition; the eye begins to protrude, and is more or less immovable; there are rapid loss of sight, high fever, intense pain, sometimes leading to nausea and vomiting, and at times great general prostration. The purulent process tends to perforate forward through the cornea or in the ciliary region. If the process begin in a purulent keratitis, the cornea generally ruptures early in the course of the disease, and the decomposed contents of the eyeball early find an exit through the corneal abscess, and the pain is therefore less severe.

Panophthalmitis always ends in destruction of the eye, and *hence all treatment* should be directed toward *hastening the suppurative process.* The surgeon can materially assist in this object by incising the cornea freely, and then eviscerating the entire contents of the eye by means of a sharp spoon, leaving the sclera as a shell behind. The hollow sclera should then be freely irrigated with a warm bichloride solution several times daily, while hot fomentations are kept constantly on the closed lids. This operation of *evisceration* is the only safe surgical procedure in panophthalmitis. *Enucleation* of an eyeball *should never be done* in this disease until all signs of purulent infection have vanished, owing to the danger of inciting purulent meningitis by extension of the process to the brain through the medium of the sheath of the optic nerve.

Intraocular Tumors.

Tumors of the Iris.—Neoplasms in the iris are relatively rare.

Cyst of the iris is comparatively a rare affection. It is either the result of sacculation in consequence of injury or operation, or it arises from the proliferation of cells introduced into the anterior chamber, as, for instance, from the introduction of an eyelash through a wound in the cornea and iris. A cyst may be situated in the substance of the iris or may consist in a simple lifting up of the epithelial layer.

It is lined with cells and grows gradually, pressing back the iris and ultimately disturbing the vision. It is always more or less translucent. If not removed the eye will be lost by general inflammation.

The TREATMENT should be complete excision, and should be left to the hand of an ophthalmic surgeon.

Nævi, or simple melanomata, are always congenital, and present the appearance of small black patches or elevations which remain stationary and cause no irritation. They consist of a circumscribed hyperplasia of the uncolored and pigmented stroma-cells of the iris. They are best left undisturbed.

Tubercles of the iris, or granulomata as they were formerly termed, are now much better understood, and their nature is perfectly identified by recognizing within them the characteristic bacilli.

They appear as grayish-red irregular nodules, generally at the periphery of the iris, and are accompanied by circumcorneal injection, haziness of the cornea or aqueous humor, photophobia, lachrymation, occasionally by some pain and disturbance of vision. Their progress may be either rapid or slow. They may multiply and fill the anterior chamber, causing increase of the intraocular tension, and eventually perforation of the eyeball, or they may grow very slowly, become arrested, and finally shrink, inducing *phthisis bulbi.* When the tubercles are mul-

tiple there is danger of general infection, and the eye should at once be *enucleated.* If the tubercle be isolated, an attempt may be made to excise it, trusting to its non-recurrence. Where, however, such a tuberculous deposit appears in the iris, its existence may be suspected in the ciliary body or choroid.

Sarcoma is extremely rare as a primary affection of the iris, and is generally melanotic in character. There is usually but a single tumor, and it may grow from any part of the iris and may occur at any age. It appears as a small, rounded, dark-brown or yellowish-brown elevation, which may remain stationary for a time, or may grow rapidly and extend into the anterior chamber, perforate the cornea, and protrude as a fungous mass. If the sarcoma be of the white variety, its growth is usually very slow.

The DIAGNOSIS between a solitary tubercle and a sarcoma is founded upon the irregular, yellowish-red appearance of the former, with injection of the neighboring parts of the eyeball, while sarcoma is more smooth and regular in outline, and less likely to be accompanied by ciliary injection.

TREATMENT.—When small, a sarcoma may be removed by excision, including a large piece of the iris. This is a very delicate operation which should be left to the ophthalmic surgeon, and it should never be undertaken unless it be tolerably certain that the neoplasm is confined to the iris. Where the growth has extended to other tissues of the eyeball or has perforated the cornea, enucleation should be immediately performed.

Among the rarer neoplasms occurring in the iris should be mentioned *lymphomata,* which have been met with in leucocythæmia, and *lepra,* which occurs in the tuberous form of the leprous dyscrasia.

Tumors of the Ciliary Body.—Morbid growths of primary origin in the ciliary body are very rare, and their exact nature is difficult to determine. Most of the tumors met with in this region have extended to it either from the iris on the one hand or the choroid on the other.

The SYMPTOMS of such a growth are but slightly marked. There would be slight local hyperæmia, a slight bulging in the ciliary region, with more or less marked discoloration of the sclera, slight bulging of the iris toward the cornea, and perhaps slight dislocation of the lens. Sarcoma of the ciliary body is about the only morbid growth met with here, though deeply pigmented epithelial growths have been mentioned by Collins.

When a sarcoma of the ciliary body has acquired any size it can be observed protruding into the anterior chamber. The iris is pushed aside from its ciliary insertion by a dark-brown tumor, which encroaches on the field of the pupil and extends backward beyond the plane of the lens. The only TREATMENT is immediate enucleation of the eyeball.

Tumors of the Choroid.—*Tubercles of the choroid* are found chiefly in cases of acute miliary tuberculosis, and especially in cases of tubercular meningitis. They appear ophthalmoscopically as distinct whitish-yellow spots or nodules in the stroma of the choroid, grouped around the region of the optic nerve and macula. They vary greatly in size, and may aggregate into larger masses. They may or may not be accompanied by retinitis or neuro-retinitis.

Solitary tubercle of the choroid is very rare, and from its size simulates the

appearance of sarcoma. In disseminate tubercle of the choroid there are rarely any symptoms, and the patients generally die of the general disease before the disease of the eye has advanced very far. No treatment is of any avail. Solitary tubercle always tends to destroy the eye and penetrate the sclera, and here enucleation of the eyeball is the only proper treatment.

Sarcoma of the choroid is by far the most frequent morbid growth met with in this membrane. It is most frequently of the pigmented variety (*melano-sarcoma*), but is sometimes free from pigment (*leukosarcoma*). A mesh of small, dark vessels forms at some spot in the retina, and the latter shows a gray opacity. If it occur near the macula lutea, vision is impaired at once. As the tumor grows its elevation may be made out, but often the retina becomes detached over it and obscures the outline. If of the pigmented variety, however, its dark color shows through.

As the growth continues and the tumor advances toward the lens, there may be a yellowish reflex from the fundus, and strong focal illumination will sometimes reveal its vascularity. The intraocular tension is usually increased, and if this be marked there is generally more or less pain. As the tumor grows it may extend in every direction, and the chief *danger lies in its extension backward* through the sheath of the optic nerve or through the lymph-channels along the vortex veins into the orbital tissue. In this latest stage there is usually some ciliary injection and some sign of intraocular inflammation, and the iris may be dilated *ad maximum* as in acute glaucoma.

The SYMPTOMS are almost entirely ophthalmoscopic.

TREATMENT.—As soon as the diagnosis is made the eye should be at once enucleated, and the optic nerve should be divided as far back as possible, near the apex of the orbit, in order, if possible, to include all the foci of disease in the enucleation.

Tumors of the Retina.—*Glioma* is a malignant tumor of the retina, and is found exclusively among young children and youths, the great majority of cases occurring in children under ten years of age. It is a comparatively rare disease.

The ophthalmoscope shows a yellowish-white growth at the bottom of the eye, which is covered by minute blood-vessels, with here and there a minute hemorrhage. At first there is neither increase of tension nor pain, but as the tumor grows the eye may become hard and the circumcorneal veins injected. The growth involves the choroid and ciliary body, and may extend to the iris and enter the anterior chamber. Later the cornea may slough, episcleral growths appear, and the orbit become invaded. At this stage the tumor grows with great rapidity, and extends in every direction, notably backward through the optic foramen and deep sinuses to the brain. *Metastatic growths* also appear in various parts of the body. Microscopically, the growth appears to originate in the outer or inner nuclear layer, and shows a delicately fibrillated reticulum, with numerous blood-vessels and small round cells with large nuclei. Very often the tumor shows the structure of a mixed growth, and is then called a *glio-sarcoma*. Sight is lost early in the course of the disease.

TREATMENT.—*Enucleation* of the eye should be advised as early as possible as the only means of preventing death, and the optic nerve should be divided as near the apex of the orbit as possible. If the growth have invaded the orbit, the entire contents of the orbit, including periosteum, must be removed.

INJURIES TO THE ORBIT.

Injuries to the Orbital Margin.—*Contusions* of the orbital margin are frequently followed by more or less extensive extravasations, which

are subcutaneous, subperiosteal, or subaponeurotic, and may extend in every direction under the skin, and even under the conjunctiva. If an artery of any size have been ruptured, the extravasated blood forms a pulsating tumor, which may render the diagnosis extremely difficult. Blows upon the margin of the orbit frequently involve the supraorbital and infraorbital nerves, and to the laceration of these nerves has been attributed the *amaurosis* which has been known to follow such injuries. This blindness is due to paralysis and subsequent atrophy of the optic nerve, and the real cause is probably a fissure or fracture of the orbit extending backward to the optic foramen.

Fracture or dislocation of the malar bone may occur from falls or blows upon this bone. Such an accident usually fractures the zygoma, and sometimes opens the suture between the malar and superior maxillary bones, and may cause extensive hemorrhage into the orbit. Anæsthesia of the infraorbital nerve from laceration in its bony canal, and annoying diplopia from injury to the inferior oblique muscle, are occasional consequences of such fractures.

Fractures of the bones of the orbit may be either direct or indirect, and may be caused by blows or falls on the head or face, gunshot wounds, and penetrating wounds of the orbit, with or without lodgement of a foreign body.

The usual SYMPTOMS are hemorrhage and displacement of the eyeball, and, in rare instances, crepitus.

Gunshot wounds of the orbit complicate the DIAGNOSIS, on account of injury to the contents of the orbit. When sudden and complete blindness occurs after such an injury and the eyeball appears intact, it may be due to *laceration* or *rupture of the optic nerve*, or to rupture of the choroid through the region of the macula.

Fractures of any one of the four walls of the orbit may occur alone or in connection with fracture of the other walls. If the inner wall be fractured, there will be displacement of the lachrymal bone, bleeding from the nose, and emphysema of the orbital tissues and eyelids.

If the *floor* of the orbit be fractured, the symptoms are hemorrhage into the orbit, bleeding from the nose or mouth, the blood coming from the maxillary antrum, emphysema of the orbit, and displacement of the eyeball by the broken fragments. Such a fracture involves both the malar and superior maxillary bones.

Fracture of the *roof* is the most serious of all injuries to the orbit. The objective symptoms are usually wanting unless the superior orbital margin is involved. When cerebral symptoms occur, they may be due to pressure or infection, and there will be pain, vertigo, delirium, paralysis, and coma. The symptoms may be long delayed, but the case is almost certain to end fatally. Death may result from meningitis, or abscess of the brain, or thrombosis of the lateral sinus.

In those cases which do not terminate fatally the most serious symptom which may occur is *blindness*. If the loss of vision be unilateral, it always occurs in the eye on the injured side, and is due to laceration of the optic nerve by the fractured bones or to atrophy of the nerves by pressure from extravasated blood. If the blindness be bilateral, the fracture extends into the middle fossa of the skull, and the loss of vision is due to direct laceration of the optic chiasm or optic tract, or to compression of the chiasm or tract by an extensive blood-clot. The ophthalmoscopic symptoms in such cases would be venous hyperæmia, arterial ischæmia, and hemorrhages on the disk and in the retina, followed by neuro-retinitis and atrophy.

TREATMENT.—This is to be conducted on general surgical principles. All perfectly loose bits of bones are to be removed, and the track of the wound should be carefully irrigated with some antiseptic solution. If abscess of the orbit develop, it must be laid open and free drainage maintained. If the eyeball be ruptured or destroyed, it must be removed at once. If the roof of the orbit be perforated and brain-symptoms appear, further exploration of the wound may be indicated, and should be carried out under the strictest antiseptic precautions.

Injuries of the Soft Parts of the Orbit.—Under this head are included the connective tissue of the orbit, the muscles, eyeball, optic nerve, and lachrymal gland. *Foreign bodies,* even of large size, may enter the orbit and pass entirely out of sight, and are often extremely difficult to find. If they do not destroy the eyeball or penetrate some one of the neighboring cavities, they may remain for a long time undiscovered. Whenever such foreign bodies can be seen or felt they should be immediately removed and the wound treated antiseptically. If the case be seen within a short time after the receipt of the injury, careful probing will often reveal a small body.

One of the most constant symptoms of the presence of a foreign body is *displacement* or *limited motility* of the eyeball. A later symptom is disturbance of vision caused by pressure on the eyeball or optic nerve. If the foreign body be sought for and found immovable, it has probably perforated one of the walls of the orbit, and great care must then be taken in its removal, especially if the roof have been perforated. If the case be an old one and the eyeball have become blind and atrophied, no attempt should be made to remove the foreign body unless the eye is first enucleated, as the foreign body is certainly encapsulated and practically innocuous. The toleration of the presence of foreign bodies of large size manifested by the orbit is sometimes extraordinary.

Laceration or rupture of the ocular muscles may be due to traumatism. There will be disturbance of motility in one or more directions ; and if all the muscles are ruptured, the eyeball will be dislocated forward entirely outside the eyelids. The internal rectus muscle is the most frequently injured. If all the muscles are ruptured and the eyeball be displaced outside the lids, an attempt should be made to replace it by means of oiled spatulas introduced beneath the lid and steady pressure backward. If, however, the optic nerve have been ruptured, the eyeball should be at once enucleated.

Hemorrhage into the Orbit.—Extravasations of blood within the orbit may come from ruptured blood-vessels in the orbit or from vessels outside of the orbit. They may be either spontaneous or traumatic, the latter being the most frequent. Blood may be extravasated beneath the periosteum, or in the orbital cellular tissue, or within the capsule of Tenon.

The CAUSES are *hæmophilia, scurvy, disease of the walls of the vessels,* or violent coughing or retching, and, finally, *traumatism* of any kind.

The SYMPTOMS are extravasation of blood beneath the conjunctiva and into the tissue of the eyelids, *exophthalmos,* and more or less limitation of motility of the eyeball. The exophthalmos is usually directly forward. Hemorrhage into the orbit after blows or falls upon the head has prognostic significance as a sign of the presence of a serious injury, as there is probably fracture at the base of the skull.

The usual course of an orbital hemorrhage ends in absorption of the extrava-

sated blood in from three to six weeks, but if it have been very extensive, with excessive protrusion of the eyeball, the latter may be destroyed by neuro-paralytic keratitis and abscess of the cornea.

TREATMENT.—Slight hemorrhages usually disappear spontaneously. The application of iced compresses and a firm bandage generally suffices for the more serious cases. If there be much pressure on the eyeball and marked exophthalmos, the blood may be let out through a free opening with a broad bistoury; but this is rarely necessary, and should always be done under the strictest antiseptic precautions.

Orbital cellulitis is an inflammation of the fatty and cellular tissue of the orbit, and may be acute, subacute, or chronic in character. It may be unilateral or bilateral. It may undergo resolution, and disappear without leaving any lasting trace of its presence; but in the great majority of cases it ends in suppuration and the formation of an abscess.

ETIOLOGY.—It may be *traumatic* or *idiopathic* in origin. If it be due to traumatism, it may arise from fracture of the bones of the orbit, from penetrating wounds with or without the presence of a foreign body, or from some surgical operation on the orbit.

The idiopathic causes may be long-continued exposure to cold, periostitis, the exanthematous fevers, meningitis, through the medium of thrombosis of the cavernous sinus or ophthalmic veins; facial erysipelas, extension of the inflammatory process from diseased teeth in the upper jaw, suppuration in the ethmoid cells or sphenoidal sinus; metastatic inflammation due to general pyæmia or puerperal septicæmia, panophthalmitis; and in rare instances inflammation in and around the lachrymal gland.

SYMPTOMS.—In mild cases there are dull pain in the orbit, slight swelling of the lids, and slight divergence and protrusion of the eyeball. In the more severe cases the attack is usually ushered in by a chill, followed by fever, deep-seated pain, headache, more or less immobility of the eyeball, swelling and discoloration of the lids, hyperæmia and chemosis of the ocular conjunctiva, exophthalmos, defective vision due to neuro-retinitis, anæsthesia, ulceration and suppuration of the cornea, ending in panophthalmitis.

TREATMENT.—If the case be of the mild type, with little or no constitutional disturbance, two or three leeches should be applied to the brow or temple, and frequently changed hot compresses to the closed lids, and iron and quinine should be administered. If the case be of the severe phlegmonous type, six or eight leeches should be applied to the brow and temples, and the hot compresses must be continually employed and frequently changed. If the swelling and exophthalmos be marked, free incisions must be made into the orbital tissue, through the conjunctiva, at the point of greatest tension, with a straight, narrow bistoury, kept parallel with the wall of the orbit; and these incisions must be kept open by a large probe, with frequent irrigation with a warm solution of mercuric bichloride (1 : 2000). At the same time the patient's strength must be supported by stimulants, quinine, mineral acids, and opiates. If panophthalmitis supervene, the eyeball must be freely opened through the cornea and the contents evacuated by pressure and a blunt spoon. This is called *evisceration* of the eyeball. When all signs of inflammation have subsided in the orbit, the blind or atrophied eyeball may then be removed by enucleation.

The **operation of enucleation** is done as follows : The patient must be

anæsthetized and the lids held open by a spring speculum. The eyeball must be grasped by fixation-forceps, and the ocular conjunctiva is then to be incised all round the corneal margin with blunt-pointed scissors. The divided conjunctiva must then be pushed away from the eyeball with the scissors and a strabismus-hook thrust under the four straight muscles and the two oblique muscles in turn, and each is divided close to its tendinous insertion in the eyeball. It is well to leave a small knob of tendon of the external rectus attached to the eye, so that it can be seized with forceps and the eye easily adducted. All adhesions between eyeball and the oculo-orbital fascia are then to be divided with the same blunt-pointed scissors. The eyeball must then be forcibly adducted, and a large pair of blunt-pointed, broad-bladed scissors, curved on the flat, must be introduced on the temporal side between the eyeball and orbital wall, and, with the blades slightly opened, carried backward until the apex of the orbit is reached. A little manipulation will engage the optic and ciliary nerves between the blades of the scissors, and they are then to be divided as far back of the eyeball as possible. As soon as all bleeding has ceased the ocular conjunctiva is to be brought together by a single stitch which covers all the remaining contents of the orbit, and a pressure bandage is then applied. This must be removed the next day, and the orbit thoroughly irrigated with a warm antiseptic solution. The bandage must be renewed for three or four days, and may then be discarded. The stitch may be removed at the end of a week.

Pulsating Exophthalmos.

Pulsating exophthalmos is a diseased condition, generally the result of traumatism, characterized by the following complex group of symptoms: (1) Protrusion of the eyeball forward, and usually a little downward and outward; (2) peculiar audible sounds over the region of the orbit and over a more or less extensive region of the skull; (3) a distinct pulsation demonstrable in the eyeball or over any spot in the region of the orbital aperture.

The lesion is situated either in the orbit or in the cavity of the skull. If in the orbit, it may be a *true aneurism* or a *spurious aneurism*. The latter may be diffuse or circumscribed, or it may communicate with both artery and vein and form an arterio-venous or varicose aneurism. If the lesion be in the cavity of the skull, it may be an *aneurism of the ophthalmic artery* at its origin from the internal carotid, or an aneurism of the *carotid* artery itself, or an arterio-venous aneurism by a rupture of the internal carotid artery in the cavernous sinus.

Symptoms.—These are exophthalmos, more or less marked; hard, dense swelling of the upper lid, the skin being livid and shining and the veins enormously swollen; loss of the tarso-orbital fold, and sometimes eversion of both lids; discoloration and chemosis of the ocular conjunctiva; slight cloudiness of the cornea, with tendency to ulceration; a hyperæmic, dilated, and sluggish iris. The eyeball can be replaced by pressure in the orbit, but the protrusion recurs as soon as the pressure is relaxed. The pulsation of the eyeball is sometimes visible as well as tangible, and is rhythmical with the pulse. In addition to the pulsation, the fingers when laid upon the eyeball will feel a more or less distinct thrill. Sometimes a soft, compressible, pulsating tumor may be felt

upward and inward from the eyeball. If a stethoscope be applied to the eyeball or the upper margin of the orbit, a more or less distinct blowing noise is heard. By compression of the common carotid artery in the neck on the corresponding side the pulsation and noise either immediately cease or become much less marked. The retinal veins are enormously dilated and pulsating, while the arteries are much reduced in calibre, and there may be all the signs of papillitis. The vision may be greatly or not at all affected. The subjective symptoms are severe pain in the orbit and head, and a constant roaring or buzzing sound, which is very annoying and is often accompanied by vertigo.

ETIOLOGY, DIAGNOSIS, AND PROGNOSIS.—The spontaneous cases occur very suddenly, are more common among females than males, and the causation is unknown unless we attribute it to extensive disease of the walls of the blood-vessels. In the traumatic cases any injury which is likely to produce a fracture at the base of the skull may cause pulsating exophthalmos, and in many of these cases the progress of the disease is very insidious and the symptoms are slow in developing. Little is known of the true pathology of pulsating exophthalmos, for even at the autopsy the true nature of the lesion cannot be determined.

It is always difficult, and sometimes impossible, to distinguish between the different varieties of pulsating tumors in the orbit. The most important point to determine is whether the pulsating exophthalmos depends on the presence of a benign or malignant tumor, on an aneurism, or on inflammation of the sinuses. Vascular tumors are more resistant to pressure than aneurisms, and their position in the orbit is usually out of the line of the axis, and their development much slower than that of an aneurism. Malignant tumors of the orbit with pulsation and exophthalmos are usually of rapid growth. Pulsating angeiomata are less painful than malignant tumors, and expand more easily after removal of the pressure. Mixed tumors, partly angeiomatous and partly aneurismal, occur in the orbit, and may be confounded with the pulsating exophthalmos. The plexiform angeiomata are essentially venous in character, consisting of a convoluted mass of distended veins held together by loose connective tissue. Here there is no pulsation and no bruit.

Another form of vascular tumor met with in the orbit is a very rare condition known as the *pulsating encephaloid tumor*. When a soft orbital tumor is found to be fluctuating and very vascular, with marked pulsation, it is almost certainly malignant and sarcomatous. It has a smooth surface like a true pulsating exophthalmos, but it does not yield as readily to pressure under the fingers. Multiple pulsating growths in and about the orbit would indicate their malignant character. A true pulsating exophthalmos occurs most frequently at the upper and inner side of the orbit.

When we come to consider those cases in which the lesion is posterior to the orbit, the diagnosis becomes extremely difficult. Most of the cases of pulsating exophthalmos consequent on some extraorbital lesion have been found to be due to a rupture of the internal carotid within the cavernous sinus, and are usually traumatic in origin. They may be divided into two classes: (1) Those in which all the symptoms are fully developed within twenty-four hours of the receipt of the injury; (2) those in which months elapse before all the symptoms are developed. The latter class is much the more numerous. The traumatism may be direct, as from a gunshot wound, or indirect, from fracture at the base of the skull and injury of the artery and sinus by a splinter of bone. In these cases the immediate consequence is an increase of ocular pressure, with signs of stasis, first seen in the superior ophthalmic vein.

TREATMENT.—The two chief surgical methods of treatment are *compression* of the common carotid artery and *ligation* of the same artery.

Compression may be either instrumental or digital, the latter being the more frequently employed. It seems better in every case of pulsating exophthalmos to begin the treatment by compression, which of course at first must be intermittent. In idiopathic cases this compression will often alone effect a cure. In traumatic cases the pressure must be continuous and kept up for several hours.

The compression of the artery against the vertebral column is best done at the level of the top of the thyroid cartilage at the anterior edge of the sterno-cleido-mastoid muscle. The advantage of compression is that it affords time for the full development of the collateral circulation, and this method is more likely to succeed in the idiopathic cases because the arterial wall is almost always diseased and frequently the seat of aneurismal dilatation, whereas in traumatic cases the walls of the ruptured artery are healthy and the conditions are not favorable for coagulation of blood in the artery. If lasting success is to be obtained in the traumatic cases by digital compression, this must be continued uninterruptedly from three to six hours at a time.

Ligation of the common carotid artery gives the most satisfactory results and is to be done in the usual place and manner. As a rule, the pulsation and bruit disappear immediately, the tumor collapses, the exophthalmos diminishes, the swelling of the lids and the chemosis vanish, the motility of the eyeball returns, and vision is gradually restored. Faint subjective sounds may return after a few hours, but the cure is generally complete in six weeks. In a small number of cases the symptoms return after ligation, sometimes on the same side, more rarely on the opposite side, and in these cases we may ligate the external carotid of the same side or the common carotid of the opposite side. In pulsating malignant tumors ligation of the common carotid artery has proved entirely unsuccessful.

In pulsating angeiomata ophthalmic surgeons prefer to employ complete extirpation of the tumor *in situ.* If the angeioma be of moderate size, it might be well to try galvano-puncture, which is a perfectly safe procedure. This method also promises good results in cirsoid aneurism and in naevus of the orbit.

In malignant pulsating tumors of the orbit complete extirpation of the mass is the only method which promises any satisfactory results.

TUMORS OF THE ORBIT.

Tumors of the orbit are divided into two classes : (1) Those which originate in the orbit, either in the orbital tissue itself, the sheath of the optic nerve, or the periosteum of the bony walls ; (2) those which arise in some one of the neighboring bony walls or sinuses, and which involve the orbit secondarily. This distinction is important, both from the diagnostic standpoint and from the side of operative interference, for the location and extent of an orbital growth frequently decide not only the question of an operation, but also its nature and extent. Many of the so-called orbital tumors arise in the ethmoid cells, the sphenoid antrum, the frontal sinus, the nasopharynx, or the maxillary antrum. The growth of these tumors is generally slow and insidious, though occasionally it is exceedingly rapid.

Orbital tumors may be either *fluid* or *solid.* The former almost always arise in the *frontal sinus* or *ethmoid cells,* and contain pus or

mucus. The latter are either solid or densely gelatinous, and are always malignant in character.

Tumors originating in the Orbit.—These include *solid neoplasms, cysts* of all kinds, and *sanguineous tumors*, classed under the collective names of orbital aneurisms. Tumors of the orbit are relatively frequent, forming nearly 50 per cent. of all orbital diseases.

SYMPTOMS AND DIAGNOSIS.—The most marked symptom of orbital tumors, which is only absent in the rarest cases, is *exophthalmos*. The degree of protrusion of the eyeball enables us to draw some conclusions as to the extent of the growth. The *direction* in which the protrusion occurs is of importance in determining the location of the tumor, it being usually on the opposite side of the orbit from the protrusion. The exophthalmos is occasionally accompanied by rotation of the eyeball, and generally by more or less marked limitation of its motility. *Diplopia* generally results from the displacement of the eyeball. Another symptom which accompanies tumors of the upper part of the orbit is ptosis.

Still another symptom which is occasionally met with is *pulsation* of the eyeball or orbital contents, which may be felt or heard, and sometimes seen. It occurs in angeiomata, encephalocele, angeio-sarcoma, and in all forms of orbital aneurism. Digital examination will sometimes aid us materially in forming an opinion as to the situation, extent, shape, resistance, and movability of the tumor, assisted by puncture with needle or trocar or by removing a small piece of the supposed tumor for microscopical examination. Disturbances in the sensory nerves and anomalies of circulation will aid us in diagnosis. Spontaneous pain, when present, is generally constant, but it is occasionally intermittent and sharp, like ciliary neuralgia.

The disturbances of vision produced by an orbital tumor are of much the same nature as those met with in orbital cellulitis, and vary in character and intensity. There may be loss of central vision, central scotomata, narrowing of the visual field, and more or less complete amaurosis from optic neuritis or from an atrophy of the optic nerve. At first the ophthalmoscopic examination is negative, but as the pressure from behind continues, and the obstruction to the return circulation becomes more complete, the retinal veins become engorged, the arteries become narrowed, and the picture becomes finally that of papillitis, with hemorrhages into the retina, retinitis, and atrophy of the optic nerve. Occasionally we meet with primary atrophy of the nerve without any signs of neuritis. In some cases a neuro-paralytic keratitis is developed, with ulceration, abscess, and perforation of the cornea, due to interference with its nutrition by the pressure in the orbit.

Though orbital tumors generally tend to grow outward and forward, they may endanger life by extension backward through the optic foramen or superior orbital fissure to the middle fossa of the skull, or they may penetrate through the roof of the orbit by caries and absorption into the anterior fossa, and destroy life in this way.

In aggravated cases the eyeball is protruded almost entirely outside the eyelids, the latter become enormously congested and distended, and the growth extends beyond the limits of the orbit upon the cheek, temple, and forehead.

Topographically, orbital tumors may be divided into four classes—viz. (1) Those which arise in the orbital cellular tissue, and which form the great bulk of all the tumors; (2) tumors originating in the lachrymal gland, and these have been considered under the head of Diseases of the Lachrymal Apparatus; (3) tumors originating in the optic nerve; (4) tumors arising in the bony walls of the orbit.

PROGNOSIS AS TO RECURRENCE.—When a morbid growth in the orbit has been removed the chances of its return are much smaller if it have been found encapsulated; and when in such a case the orbit again

becomes filled, we must assume either a nidus of disease left behind or a new secondary tumor. The size and rapidity of growth of a tumor are usually indicative of its nature. As a rule, the more developed the cellular element of a tumor is, the more rapidly does it grow. When such a tumor recurs after extirpation, the secondary growths are always richer in cells than the original tumor and grow much more rapidly.

Tumors which Arise in the Orbital Cellular Tissue.—*Cysts.*—This class includes encephalocele, extravasation-cysts, pigment-cysts, exudation-cysts, retention-cysts, dermoid cysts, echinococci, and cysticercus.

Encephalocele is a hernia from the brain into the orbit through an opening in the suture between the ethmoid and frontal bones, the lachrymal bone being generally entirely absent. It is always congenital. The amount of displacement of the eyeball depends on the position of the hernial ring. There may or may not be pulsation in the tumor. It increases rapidly in size and life is prolonged merely for a few months. These cases do not admit of any treatment.

Extravasation-cysts include the blood-cysts, hæmatocele, and hæmatoma, and also the pigment-cysts or melanotic cysts. Very few cases of true blood-cysts of the orbit are on record, for most cases of cystic formation in the orbit with bloody contents have been originally instances of dermoid cysts in which exploratory punctures have produced a hemorrhage.

Exudation-cysts.—Of this class there is but a single variety in the orbit, the hygromatous degeneration of the tendinous bursæ.

Retention-cysts, or *follicular cysts,* form a large class, and include the atheromata, steatomata, and cholesteatomata. They are simply varieties of true dermoid cysts.

Dermoid cysts are fœtal structures resulting from the invagination of the external blastodermic membrane. They are round, with thick, vascular walls lined with endothelium, and may be unilocular or multilocular. They increase slowly in size, and their contents consist of epithelium or epidermis, hairs, fluid fat and fat-crystals, fluid, gelatinous, or solid constituents, chalky deposits, and even skin and teeth.

Echinococcus cysts are surrounded by a framework of connective tissue, and the cavity is filled by the mother-cyst, in which are the cysts of the third generation floating in a liquid. They may extend to the frontal sinus, and even into the cavity of the skull. Ciliary neuralgia is almost a constant symptom in this disease.

Cysticercus in the orbit is very rare. The sac is surrounded by a very thick connective-tissue envelope. The symptoms are fluctuation, redness and sensitiveness of the skin of the lids, pain, and displacement of the eyeball.

An encephalocele is distinguished by its congenital origin, location, bilateral character, and pulsation. All the cystoid tumors are characterized by fluctuation, and in doubtful cases an exploratory puncture would aid in the diagnosis, especially if assisted by chemical and microscopical examination of the contained fluid.

TREATMENT.—The treatment of all these cystoid tumors should be *surgical*, and the operation should be the total excision of the cyst. The eyeball should be left intact, unless it be found that the cyst cannot be removed entire without first enucleating the eye, in which case it must be sacrificed, even though still capable of useful vision.

Angeiomata.—*Simple angeiomata* include the nævus maternus and the teleangiectasiæ of the lids and orbit. They are rarely met with in the orbit alone, the eyelids and neighboring skin being usually involved. They are always congenital, and appear as soft, slightly compressible tumors on one side of the eye.

Cavernous angeiomata include the erectile tumors and the aneurisms by anastomosis. They are met with in all parts of the orbit, but are

more frequently found behind the orbit, and are surrounded by a thick capsule of connective tissue. They pulsate spontaneously, are firmly elastic, of slow development, and generally painless.

The PROGNOSIS is favorable, and they occasionally heal spontaneously. The chief danger lies in loss of vision from pressure on the optic nerve.

TREATMENT.—The treatment should always be by operation, and total extirpation of the tumor gives the best result. In some cases of small angeiomata and of teleangiectasiæ electrolysis may be tried, and has been known to produce a gradual diminution in the size of the tumor. The electrolysis must be repeated a number of times at short intervals.

Lipoma of the orbit, unconnected with the eyelids, is a rare disease, and must be differentiated from general hypertrophy of the fatty connective tissue of the orbit.

Enchondroma.—The cases hitherto reported of enchondroma of the orbit are described as tumors of a cartilaginous character developed in the fatty tissue of the orbit, and by Berlin have been classed among the cylindromata (probably endotheliomata).

Orbital Tumors of Epiblastic Character.—Under this general classification have been grouped three different varieties of tumor which have certain general resemblances—viz. epithelial carcinoma, adeno-carcinoma, and adenoma. Strictly speaking, none of these tumors arise in the orbit, but all start from the lids, the lachrymal gland, or some one of the neighboring sinuses.

Orbital Tumors of the Connective-tissue Type.—These are solid, with more or less uneven surface, and with neither fluctuation nor pulsation. They are neither compressible nor very hard. They may involve one or more of the neighboring cavities, but are much more likely to originate in some one of the neighboring cavities and extend to the orbit secondarily.

The microscope alone can establish the DIAGNOSIS as to the true nature of such a tumor. The younger the patient is, and the more numerous the cellular elements are, the more rapid is the growth of the tumor and the greater certainty there is of a return. In cases of pigmented tumors the diagnosis must largely depend on the dark color of the growth, and even then such a tumor may be confounded with a cavernous angeioma. These *melanotic* tumors show a strong tendency to extend toward the intracranial cavity and to the development of metastatic growths in various parts of the body.

TREATMENT.—The treatment of all these tumors consists in complete extirpation at the earliest possible period.

Tumors which Arise from the Bony Walls of the Orbit.—*Cysts of the Orbital Walls.*—Echinococcus and serous cysts, as well as cholesteatomata of the orbital walls, have probably originated as cysts of the frontal sinus.

Osteosarcoma.—Almost the same statement may be made of the so-called osteosarcoma of the orbital walls. The participation of these bony walls in the process is generally only part of very extensive disease of the other bones of the skull, and it is impossible to point out the place of origin of such growths.

Osteoma of the Orbit.—Under the general head of osteoma are classed, for convenience, osteophytes, periostoses, hyperostoses, and exostoses, as well as true ivory osteomata. (*Vide* Vol. I. Chap. XXVI.)

These bony tumors are met with most frequently in the upper and inner angle of the orbit, and generally in the frontal bone. They may be unilateral or bilateral, and are generally hemispheroidal in shape, with a broad base of attachment. Their surface may be smooth or nodulated. They may start in a neighboring cavity and involve the orbit secondarily.

Their ETIOLOGY is very obscure.

SYMPTOMS AND COURSE.—They grow very slowly, are never sensitive to pressure, and when they cause pain it is either from pressure on some sensory nerve or from some localized inflammation. There is exophthalmos, more or less limitation of motility of the eye, sometimes ulceration of the cornea and disturbance of vision, with diplopia. Ophthalmoscopically, there may be noticed all the changes in the retina and optic nerve from hyperæmia, through papillitis, to atrophy of the optic disk. If the cavity of the skull be encroached upon, grave cerebral symptoms will result. They are extremly hard and immobile. A careful examination must be made of the condition of the various neighboring cavities, for such a tumor may be mistaken for a distention of the ethmoid cells or frontal sinus.

If confined to the orbital wall, the PROGNOSIS is favorable.

TREATMENT.—The treatment of pure osteoma or ivory exostosis consists in its operative removal. This is very tedious, somewhat difficult, and, if the roof of the orbit be involved, the danger to life is by no means slight, statistics showing a mortality of 38 per cent. The periosteum must first be incised and carefully stripped off from the tumor and for some distance from its base. Then a narrow groove should be cut with a chisel or gouge and mallet around the base, the blows with the mallet being made gently and rapidly until the tumor becomes loosened. Then a gentle rocking motion to and fro will usually suffice to detach it. If the bone be found very dense, small holes may be drilled in it by means of a dental engine, and the operation subsequently completed by a chisel and mallet. These tumors show no tendency to recur.

TUMORS OF THE OPTIC NERVE.

Tumors of the optic nerve, originating in the nerve-fibres or sheath of the nerve, are rare. They may involve any portion of the nerve between the eyeball and the optic chiasm, but in by far the greater number of cases the orbital part of the nerve is the seat of the growth.

These tumors vary in size from that of a hazelnut to that of a large egg. Sometimes the nerve passes through the centre of the tumor and is spread out in it, and more rarely it is found on one side of the growth. The tumor grows either from the dural sheath, or from the pial sheath, or from the stem of the nerve. Tumors met with in this locality may be epitheliomata or endotheliomata, sarcomata, gliomata, myxo-sarcomata, fibro-sarcomata, and neuromata. In all these varieties cystoid degeneration is frequently met with. Most of the cases reported have occurred in young persons before the age of puberty. The endotheliomata usually grow from the dural sheath, the sarcomata from the pial sheath, and the neuromata from the neuroglia of the nerve. In all cases the optic nerve is more or less flattened and atrophied.

SYMPTOMS.—These vary with the size, shape, and location of the growth. Optic neuritis, or papillitis and atrophy of the optic nerve, with resulting loss of vision, are early symptoms. The progress is slow and usually painless. The protrusion of the eyeball is generally straight

forward in the direction of the axis of the eye, and, unless the tumor be large, the motility of the eyeball is not much interfered with, though diplopia may be present from the beginning. In rare instances the growth may be so rapid as to interfere with the nutrition of the globe, and ends in perforation of the cornea and atrophy of the eye.

It is rarely possible to diagnosticate correctly a true tumor of the optic nerve, as most of the symptoms are common also to cases of orbital tumors which may have involved the optic nerve secondarily.

TREATMENT.—This consists in removal of the growth by operation. An attempt should always be made to remove the tumor without enucleating the eyeball, and this has been successfully done in a number of cases. If, however, the tumor be of large size or have involved the orbital tissue extensively, the entire contents of the orbit, including the eye, must be removed. Recurrence of the growth in the latter case occurs but rarely.

AFFECTIONS OF THE EXTERNAL MUSCLES OF THE EYES.

Strabismus, or Squint.—The subject of strabismus can receive but very brief mention in a work on General Surgery, as its intimate connection with errors of refraction, with congenital amblyopia and arrest of development of the retina or optic nerve, or both, and with possible undeveloped conditions of the nuclei of origin of the motor nerves, or with abnormally increased nervous inhibition, make it the most obscure and complicated chapter in ophthalmology.

Strabismus, or *squint,* is that condition of the eyes in which the visual axes of the two eyes, when prolonged, do not meet in the object of fixation. If these prolonged axes meet before reaching the object of fixation, the condition is termed *convergent strabismus.* If these axes when prolonged never meet, but diverge from each other, the condition is known as *divergent squint.* Either of these conditions may exist alone or may be accompanied by loss of power or paralysis of the antagonistic muscles of one or both eyes. In the former case the deviation is termed *primary squint;* in the latter it is known as *secondary* or *paralytic squint. Primary squint* is almost always associated with some *error of refraction,* usually hypermetropia, and generally with marked impairment of vision of the squinting eye. In the comparatively rare cases in which the deviation exists in both eyes there is commonly a difference in the degree of refractive error and in the acuity of vision of the two eyes.

A *convergent* squint may exist at times in one eye, and at times in the other, and is then called *alternating.* It may at times exist and at times be absent, and it is then called periodic. In *primary* squint there is almost never any diplopia. In *secondary* or paralytic squint, if the vision of both eyes be good, diplopia is almost always present.

Primary squint is almost always an affection of early childhood. *Secondary* or paralytic squint may occur at any period of life.

ETIOLOGY.—The causes of *primary* squint are very obscure, and are intimately associated with errors of refraction, increased nervous inhibition, and certain conditions of general nerve-supply as yet but little

understood. *Secondary* or paralytic squint is due either to some local focus of disease in the orbit or brain, to some general blood disorder like syphilis, or to traumatism.

TREATMENT.—In the case of *primary* convergent squint the treatment is partly optical by means of properly fitted lenses, and partly surgical, and should be undertaken solely by the ophthalmic surgeon. In the case of *secondary* or paralytic squint the treatment should be directed, first of all, to the constitutional cause of the affection, and subsequently such surgical operations should be undertaken as may be indicated to restore the disturbed motility of the eyeball.

Paralysis of the External Ocular Muscles.—Paralysis of the ocular muscles may be due to some general blood disorder, such as syphilis or rheumatism ; to foci of disease in the brain ; or to traumatism, whether accidental or surgical. Any single muscle may be paralyzed or all the external muscles of the eye may be involved in the same process.

The *external* rectus muscle, supplied by the sixth nerve, is much more frequently paralyzed than any other ocular muscle, and the paralysis may be temporary or permanent. The symptoms are an absolute immobility of the eye outward, a secondary convergent squint, and double vision.

Next in order of frequency is a paralysis of the *muscles supplied by the third nerve*, any one of which or all of which may be affected. These symptoms are diplopia ; divergent squint or upward squint or downward squint ; ptosis ; immobility of the eye inward, downward, or upward ; dilatation and immobility of the iris ; and loss of the power of accommodation. The two latter symptoms point to paralysis of the branches of the third nerve going to the iris and ciliary muscle. The position of the double images with reference to each other varies with the muscle or muscles paralyzed, and is of too complicated a nature to be entered on here.

When all the branches of the third nerve are involved the condition is known as *ophthalmoplegia externa* and *interna*.

Paralysis of the *superior oblique* or trochlearis muscle is due to a lesion of the fourth nerve or its nucleus of origin. It is a rare occurrence, and the objective symptoms are so slight that the paralysis cannot be determined except by close examination of the behavior of the double images.

TREATMENT.—The treatment of all these muscular paralyses should be directed toward obviating the cause, and is generally medical in character.

Nystagmus.—This is a term applied to involuntary oscillatory or rotary motions of the eyeballs due to rapid alternate contractions of one pair of straight muscles, or to similar action on the part of the oblique muscles, or to both combined. It may be either congenital or acquired. The former is accompanied either by cataract or by imperfect development of the retina or optic nerve. The acquired form may be due either to corneal opacities or to fatigue of the nerve-centres of the eye by working in a strained position, as in miners. It is also a symptom of disseminate sclerosis of the brain and spinal cord.

TREATMENT is of no avail.

SURGICAL INJURIES AND DISEASES OF THE EAR.

By Clarence J. Blake, M. D.

The surgery of the ear may be divided, operatively speaking, into *General* and *Special*, the former including such operations as come within the province of the general surgeon, and the other those requiring the manipulation of minute instruments directed by sense of touch in a field illuminated by reflected light, approached through a small opening, and confined to a cavity which presents a great variety of structures and intimately related contiguously to important parts, the invasion of which would be a matter of serious consequence. Indeed, the surgery of the temporal bone requires to an unusual degree a knowledge of minute anatomy and a tactile appreciation of locations and distances.

The first class of diseases and their operative relief would, under this division, include the treatment of the malformations, injuries, and diseases of the external ear, of the outer portion of the external auditory canal, and of the superficies of the mastoid process, while the second class would include the special operations upon the membrana tympani, within the tympanic cavity, and in the depths of the mastoid.

The congenital deviations of the auricle from the normal type include *malpositions of the auricle* as a whole ; *deformities* of certain portions of the auricle, the remainder being normal ; *anomalous shape of the auricle*, resulting either from injury or from arrest of development during intra-uterine life ; and, finally, the presence of either *supernumerary auricles* or of *supernumerary portions* of the auricle.

The malformations most commonly demanding surgical treatment are those in which there is a marked arrest of development accompanied by impairment of hearing, those in which supernumerary portions are to be removed, and those in which the auricle, in other respects normal in position and structure, projects unduly from the side of the head.

In very young children the *projecting auricle* may, since the cartilage of which this structure is formed is at an early age soft and pliable, be *successfully treated* by fastening the auricle back against the side of the head, either by painting the posterior portion of the concha and the adjacent portion of the mastoid region with collodion, bringing the two surfaces in contact, and applying a light gauze bandage, or by applying the bandage alone, or a cap which may be continuously worn : in the adult this simple treatment is less efficacious, because of the greater elasticity and firmness of the cartilage, but that it may occasionally be effectual is shown by the result of the pressure of the head-band worn by some orders of religious sisterhoods.

When the auricle is very prominent and the cartilage thick and firm, it is usually necessary to effect an attachment between the posterior portion of the concha and the surface of the mastoid region. This is best

done by *removing an elliptical portion of skin*, including a part of the posterior surface of the auricle and of the mastoid, in one denudation, the edges of the cut upon the auricle and mastoid being brought into apposition and secured by stitches : a light but firm bandage is then carried over the auricle and around the head, and, except for renewal, should not be removed until the healing of the wound is complete. Where the cartilage of the auricle is thick and unyielding, it may be thinned either by means of the curette or knife, care being taken that this is done evenly ; otherwise when the auricle is pressed backward, a break may occur in the cartilage at the thinnest point, with the resulting deformity of a projection upon the anterior surface of the auricle.

As a preliminary to this operation, in addition to the usual cleansing of the skin and other aseptic precautions, the auricle should be pressed backward into the position in which it is desired to fasten it, and a mark made upon the concha and mastoid to indicate the limit and contour of the incision to be made.

The commonest form of *complete microtia* is that in which the tubercles of cartilage which subsequently form the helix, antihelix, and the tragi are still distinct, and, since it is the result of an arrest of development at an early period of intra-uterine life, it is not uncommonly accompanied by an arrest of development of the corresponding side of the face, of the external auditory canal, and sometimes of the sound-transmitting structures of the middle ear.

The rudimentary auricle itself contains so little basal cartilage, and is in the majority of these cases so merely an involuted reduplication of skin, that it affords very little material for a plastic operation, and, so far as appearances are concerned, is better left untouched, entirely removed, or replaced by an artificial representation of a normal ear ; while the incompleteness of the deeper portions of the organ of hearing of which this form of microtia is significant, give in the majority of cases but little hope of an improvement in the hearing by operative interference.

The *supernumerary portions* of the auricle most commonly found are small nodules of cartilage or of connective tissue, covered with skin, in front of the ear, which may itself be quite normal in shape, size, and location. These projections are easily removed by excision, a small flap of skin being taken from one side and stitched or otherwise secured in the space left by the removal.

Incised and contused wounds of the auricle are likely to result in a considerable degree of deformity, either from imperfect coaptation of the edges of the wound or from subsequent perichondritis or necrosis of the cartilage, unless they are treated shortly after injury and with especial reference to the peculiar structure of the auricle. This is a thin plate of unsupported cartilage covered with integument, and subjected, in the event of a solution of its continuity, to the action of small muscles, which, though rudimentary and weak, become effective in their action when the continued resistance of the cartilage to which they are attached is removed.

Where operation is requested for the relief of such deformity resulting from injury, as the incurving of the pinna from above forward, this may be effected by subcutaneous dissection of the integument on the anterior surface of the auricle, and by an operation on the posterior surface comparable on a small scale to that made use of for tying back the auricle as a whole.

As a *result of blows* upon the auricle there is not infrequently a *severe contusion* or *fracture of the cartilage*, with extravasation of blood underneath the integument and perichondrium: this occurs usually on the anterior surface of the auricle and in its upper portion, and is similar in appearance and location to the extravasations which have been found to occur, without history of injury, in the insane, and have been produced artificially in dogs by section of the restiform bodies, except that the *traumatic othæmatoma* is usually larger, more tense, and accompanied by pain.

In the traumatic othæmatoma the extravasation of blood which peels up the perichondrium and skin is usually the result of a fracture of the cartilage, while in the idiopathic form there is sometimes a disease of the cartilage as the basis of the hemorrhage or effusion.

The *othæmatoma* usually presents itself as a smooth rounded swelling, filling the upper anterior portion of the auricle above the concha, and obliterating the normal elevations of the helix, antihelix, and their corresponding fossæ; it occurs either immediately after an injury, when it is accompanied by sensations of pain and tension, or idiopathically, without pain or other disturbance, sometimes during sleep, the patient awaking with a sense of fulness in the auricle as the first evidence of an abnormal condition.

The TREATMENT of the recent othæmatoma should be directed, first, to the evacuation of the contents of the sac, and, secondly, to the prevention of deformity, which is likely to occur from the contraction of remaining blood-clots, the puckering of the skin, and the consequent malposition of the fractured or weakened cartilage.

Evacuation by *aspiration*, while immediately effectual in removing the serum, is apt to leave a remaining blood-clot and give, moreover, only temporary benefit, since the sac speedily refills; a free incision should, therefore, with due aseptic precautions, be made in the most dependent portion of the tumor and the fluid contents evacuated, not only by gentle pressure from above downward, but by passing a cotton-tipped probe, properly sterilized, into the sac and carefully wiping out any remaining blood-clots or small pieces of cartilage, which, both in the traumatic and idiopathic cases, are sometimes found to have separated.

If the othæmatoma is of long standing and the cotton-tipped probe be not sufficient to cleanse the sac-walls, the sharp spoon should be used and the walls effectually curetted. After evacuation of the sac complete apposition of the walls should be effected by applying to the anterior surface of the auricle, over the evacuated sac, small pads of sea-sponge cut to fit into place, wrung out in boiled water, partially dried, and kept in place by a narrow flannel bandage passing over the auricle and around the head, the auricle being supported posteriorly by gauze sponges. At the end of twenty-four hours the bandage and pads should be removed, care being taken, if there be evidence of adhesions between the sac-walls, to hold the auricle between the thumb and finger after the pressure of the bandage is removed.

If the sac refill, the evacuation and bandaging should be repeated; more than three or four daily dressings are seldom required to bring about adhesion of the walls of the sac, and when this has been effected the auricle should be massaged by a gentle rubbing or rolling

of the affected part between the thumb and finger for five or ten minutes three or four times daily.

The *auricle* is frequently the seat of *small warty growths* occurring usually on the walls of the concha, of small cysts, and occasionally of gouty deposits, all of which may be treated according to the simple rules applicable to the removal of such abnormalities elsewhere.

The *lobule* is occasionally the seat of *fibrous tumors*, rarely attaining any considerable size or occurring frequently except in the negro race. When these tumors are large it is sometimes necessary to sacrifice the whole lobule, the tumors being removed by careful dissection, leaving a small flap of skin to be turned under the lower edge of the cartilage of the auricle to form a small lobule; tumors of moderate size may be included between two cuts of the scissors, making a triangle, the apex of which should be below the cartilage, the space between the two lines including the tumor and such portion of the lobule as it may be necessary to remove in order to get good opposing edges: care should be taken not to carry the cut upward into the cartilage, as the small artery running along its inferior border is likely to cause troublesome bleeding, interfering with the subsequent healing of the cut edges, which should be brought into apposition and secured by means of collodion dressing and without sutures, experience having shown that the suture points are liable to become centres for new fibroid growths.

Epithelioma of the auricle is of infrequent occurrence, a review of 14,747 cases of all diseases of the ear showing that it occurred but twice. Relief is most commonly sought on account of the severe pain which accompanies the development of the nodular projection upon the anterior surface of the auricle, the primal appearance of a carcinomatous growth being rare on the posterior surface.

When a large portion of the auricle has been attacked, its entire removal, with that of a part of the whole of the cartilaginous canal, is indicated, and this should be done in the following manner: The skin should be carefully examined to determine the location of any nodular points, all of which in the immediate neighborhood of the auricle should be included in the field of operation, and the incision should be made beyond the indurated surface and in the sound tissues only. Beginning at a point above and behind the auricle, the first incision should be made as close to the point of auricular attachment as the condition of the skin will permit, and the dissection carried backward and downward in a curve to a point below the lobule: from this incision the skin should be dissected up, and the dissection carried along the curve of the mastoid into the auditory canal, thus separating the posterior auricular attachments and carrying the auricle with its collar of skin forward, traction on the auricle forward, upward, and downward, as the cutting proceeds, permitting a ready division of the muscular and ligamentous attachments above and below.

The superficial cut is then continued from its beginning forward and downward outside of the root of the helix, above the tragus, and into the meatus, while the end of the cut is continued either through the incisura intertragica, leaving the tragus in place, or outside of and including the tragus in case it be necessary also to remove that portion of the cartilage.

The removal of the auricle in cases of epithelioma sometimes implies the creation of a surface of greater or less extent to be covered by granulation-tissue, and the utilization of any skin-flaps which may be obtainable without danger of a recurrence of the growth should of course be considered. Where the upper portion of the auricle only is implicated and the lobule may be left, it can be utilized for covering; the lobule,

which is merely a reduplication of skin, vascular and well nourished, and with a small artery passing into it from a point on its anterior border, may be separated in removing the cartilaginous portion of the auricle, left hanging by its anterior attachment, and, after removal of the auricle be used by splitting and spreading to cover a considerable denuded surface. Where it has been necessary also to denude a large portion of the mastoid surface a long incision may be made in the scalp posteriorly to the mastoid, the subcutaneous tissue dissected up, and the scalp slipped forward to cover as large a portion of the mastoid as is possible by this means, the scalp opening being allowed to close by granulation-tissue ; the aural wound should be dressed antiseptically, a gauze tampon being placed in the external auditory canal, and when granulations appear over the surfaces which it has not been possible to cover with skin, dermatization may be effected by first drying the granulation surface and then carefully covering it with a strip or strips of bond or so-called parchment paper, which is kept in place under pressure by means of sterile dressings and firm bandages. At the end of the third or fourth day the paper is usually either firmly adherent or comes away, leaving beneath it flattened granulations covered with a fine pavement epithelium. In using this form of automatic grafting the paper dressing should, if possible, be applied in one piece and carried over on to the sound skin, new skin-growth being found, under these conditions, to project itself in concentrating lines from the sound edges toward the centre of the granulating surface.

Injury of the External Canal.

Among the injuries to the external auditory canal of extrinsic origin should be mentioned fracture of the anterior inferior wall of the bony canal, forming the posterior wall of the glenoid fossa, as a result of blows upon the lower jaw, the bony plate in some cases being not only fractured, but turned up edgewise through the skin into the lumen of the canal.

Foreign Bodies.

The foreign bodies which find their way into the ear, and for the removal of which interference is required, are of two classes—the *animate* and *inanimate*, the former including various insects and their larvæ, and the latter almost any substance small enough to be introduced into the external auditory canal.

The presence of an *animate body* is usually evident to the patient by sensations of movement within the ear, and of pain accompanied by noises incident to the movement of the living creature. The speediest relief from these symptoms is afforded by turning the affected ear upward and filling it with either warm water or warm oil for the purpose of drowning the insect, which may afterward be removed by means of the forceps under a good illumination, or by simple syringing.

The larvæ of the house-fly and blow-fly are sometimes found in the ear in cases of suppurative disease : their presence may usually be determined objectively as a whitish moving mass in the depth of the ear, and an occasional indication of their presence is the streaking of the purulent discharge with blood flowing from the mucous membrane, wounded by the hooks with which the larvæ attach themselves,

the subjective symptoms being a sharp stinging pain in the ear accompanied by a sensation of movement. An attempt at removal of the larvæ by means of the forceps not uncommonly results in their being torn to pieces, traction upon their bodies drawing the hooks downward and fixing them more firmly in the skin or mucous membrane. As their breathing apparatus is at the ventral end, they may be made to loosen their hold by filling the ear with warm oil or glycerin.

The *inanimate bodies* most commonly found in the ears of children are beans, peas, pieces of slate-pencil, beads, boot-buttons, small shells, and pebbles. Where the foreign body is situated in the outer half of the canal it may sometimes be easily removed by turning the affected ear downward, seizing the auricle between the finger and thumb, and rotating it forward and backward, this movement serving to make the wall of the cartilaginous part of the canal impinge upon one side and then the other of the foreign body and loosen it from its place. If the foreign body have been pushed beyond the narrow portion of the canal and is lodged near to or in contact with the drumhead, its removal should be attempted, otherwise than by syringing, only under a good illumination and *with great care*, it having not infrequently happened that injudicious attempts at removal of a hard foreign body by means of forceps and other instruments have resulted not only in *wounding* the lining *of the canal*, but in *rupturing the membrana tympani* and forcing the foreign body into the tympanic cavity.

When the foreign body is so firmly imbedded at the inner end of the canal or in the middle ear as to make its extraction by the natural channel impossible, it may be necessary to reflect the auricle and cartilaginous portion of the canal, or even its entire lining, forward. This should be done under ether and with the usual aseptic precautions, an incision being made behind the auricle close to its attachment, and the dissection along the posterior wall of the canal being carried to the point of attachment of the cartilaginous to the osseous portion, which may then be separated, exposing the inner end of the canal, with its soft tissues intact, freely to view; or, without dividing the canal, the soft parts may be entirely dissected away from the bone as far as the emulus tympanicus, the soft tissue at this point being divided by the angular knife introduced through the canal or by further dissection from behind forward: should the foreign body be so large, of such material, or so firmly imbedded in the middle ear as to make its piecemeal extraction necessary, the first incision should be made not merely behind the auricle, but should begin above it, in order that a larger operative field may be obtained and that room be secured, if necessary, for cutting away portions of the bone.

After removal of the foreign body the ear should be thoroughly cleansed with an antiseptic solution, the soft parts replaced, and the outer wound closed by stitches.

The External Auditory Canal.

The commonest form of acute infectious process of the external auditory canal is *furuncle*, or *boil*, which is found principally in the outer portion of the canal, and rarely in the concha or upon the auricle. These boils of parasitic origin occur singly, more commonly successively in groups, and have all the characteristics of the same form of inflammatory process elsewhere, but are liable to be especially painful because of the circumscribed region in which they occur, the thinness of the skin, and the resisting character of the underlying tissues.

In addition to the pain, which is at first dull and continuous and later of a lancinating character, there is a sensation of heat and fulness in the ear. In the earlier stages, when the skin is red and tumefied, the exact

location of the inflamed gland may be determined by tactile inspection with a bent probe, pressure on the skin immediately overlying the point of inflammation being indicated by a slight sharp pain. Gentle pressure with the probe marks the spot by a momentary depression in the œdematous skin, and a deep incision with a small curved bistoury usually brings the desired relief.

In the limited necrosis of the bony canal which accompanies an ulcerative process of the soft tissues, following either circumscribed or diffuse inflammation, the more common locations of the lesions are the rough lip of bone which forms the inferior outer termination of the osseous auditory canal and serves for the attachment for the cartilaginous portion, and the thin bone on the posterior wall of the canal.

The SYMPTOMS which bring patients under observation in these cases are either the discomfort incident to a flow of pus from the ear or an impairment of hearing, accompanied by a sense of fulness or other indication of the presence of a foreign body in the canal, and which is found on inspection to be due to an accumulation of epidermis. On further examination it is evident that both the pus and exfoliated epidermis have their origin in granulations which overlie a small surface of necrotic bone.

The occurrence of a large furuncle at the junction of the cartilaginous and osseous portions of the canal, followed by subsequent ulcerative destruction of the thin upper dermoid wall, will sometimes leave a cavity of considerable depth either filled with granulation-tissue or with masses of exfoliated epidermis, the removal of which by means of the forceps or by syringing reveals the true condition of affairs, the depression in the wall of the canal being found to have somewhere upon its surface redundant granulations, at the bottom of which, by means of a probe, a spot of carious bone may be felt. In the majority of these cases relief is obtained by the simple process of thorough and sometimes repeated curetting through the external canal, but it is occasionally necessary where the necrotic portion is more extensive to reflect the auricle forward in search of a sequestrum or for the purpose of removing the diseased bone by means of the chisel.

Exostoses of the external auditory canal, like the hyperostoses, are usually the result of a circumscribed periostitis, such as may occur in the course of a chronic suppuration of the middle ear, though their occurrence as multiple growths in succeeding generations favors the imputation of an hereditary tendency.

The *hyperostoses* rarely require operative interference, but the *exostoses* of large size which have their origin on the anterior superior or posterior inferior lip of the osseous meatus, as well as the rounded exostoses which occur singly or in groups deeper in the canal, sometimes project so freely into its lumen as to make their removal a necessity.

A careful examination of the contour and location of an exostosis is an important preliminary to its removal, and this may be done with a bent probe passed beyond the growth or by means of the loop of a wire snare slipped over it.

The removal of exostoses is best effected by means of a fine dental drill making successive openings through the base of the growth, which is then broken away by means of the burr worked by a dental engine.

Another form of obstruction of the external auditory canal, but one

involving the soft tissues only, is that which follows the **granulomata** occurring in the canal as the result of an ulcerative process incident to suppurative middle-ear disease or otherwise, and consists usually in an annular constriction or narrowing of the canal by secondary granulation-tissue. Dilatation of the constriction by sea-tangle tents, either with or without previous multiple incision, is frequently of doubtful result, and in some of these cases the following procedure has proved of service, its object being to remove the redundant tissue and at the same time to preserve the continuity of the dermoid lining of the canal.

With a sharp curved bistoury, passed beyond the point of constriction, a triangular incision is made on the wall of the canal, with the base of the flap thus formed outward. By means of a sharp curette the apex of the skin-flap is lifted and gradually dissected outward to the base, turned outward, scraped clean of all redundant tissue, and replaced; after a thorough curetting of that portion of the constriction which lay beneath it, the canal is then cleansed antiseptically and the flap kept in position by a tampon until union has taken place.

THE MEMBRANA TYMPANI AND THE TYMPANUM.

The membrana tympani, while exceedingly firm and resistant, is comparatively inelastic: it may therefore be *ruptured* throughout by such application of general force to its whole surface as would accompany the sudden condensation of air in the external canal or middle ear; it may be torn across as an effect of contre-coup in consequence of a *blow on the opposite side of the head;* or it may be wounded by the *impact of some foreign body* introduced through the external canal. In the first and second instances there is usually a solution of continuity of all the coats of the drumhead, the laceration extending from one periphery to the other, and commonly parallel with and close to the long process of the malleus, while in the latter case the injury is usually limited to a small area around the point impinged upon; in both classes of cases the rent is an irregular one, and, as the mucous coat of the drumhead is exceedingly vascular, the injury is likely to be accompanied by hemorrhage into the tympanic cavity. If the *rupture* of the drumhead be an extensive one, with bleeding into the tympanum, and the injury be recent, the middle ear should be gently inflated by means of the Politzer air-douche or catheter, and the meatus carefully cleansed, a dry cotton-tipped probe being used in preference to the syringe: if syringing is rendered necessary by the presence of an extraneous substance or of cerumen or epidermis in the canal, this should be done only with sterilized water or an antiseptic solution: after cleansing, the ruptured edges of the membrana tympani, if not already in contact, should be placed so by gentle manipulation with a cotton-tipped probe from without and by inflation of the middle ear from within, it being borne in mind that the less the parts are handled the better; but the apposed edges of the cut may be covered by a paper dressing previously dipped in sterilized water or a weak corrosive-sublimate solution.

A blood-clot in the healthy tympanic cavity is a matter of little moment, except in so far as temporary interference with sound transmission is concerned, and the structure of the drumhead is such—there being a fibrous coat in two layers, the outer of which is made up of radiating and the inner of circular fibres placed between an outer dermoid

and an inner mucous coat—that when wounded or ruptured the edges of the cut or wound tend to return to a normal position and come together. The ear should finally be closed with cotton and the patient directed to avoid blowing the nose for at least forty-eight hours.

In those cases of **chronic, non-suppurative middle-ear disease** where operation is undertaken with a view to possible improvement of the hearing, and in other cases of the same class where the exact determination of the character and location in the sound-transmitting apparatus of the obstacles to the passage of the sound-waves is a matter of difficulty, the question of some method of **exploratory operation** which shall take advantage of the intelligent participation of the patient is a matter of importance.

Tactile investigations as to the comparative sensitiveness of different portions of the tympanic cavity show its lining membrane and intrinsic structures, with the exception of the superior and posterior portion—fornix tympani and aditus ad antrum mastoideum—to be comparatively insensitive.

Operations within the middle ear, therefore, except such as include interference with the membrana tympani and invasion of the upper portion of the tympanic cavity, may, in the great majority of cases, with proper care, be conducted not only without general, but also without local, anæsthesia; and in the cases, therefore, of chronic non-suppurative disease of the middle ear with intact membrana tympani, for which this operation of exploratory tympanotomy is proposed, when the sensitive membrana tympani has once been passed there is opened to the observer an aseptic and comparatively insensitive cavity.

The operation should be preceded by that thorough cleansing of the external auditory canal and of the instruments which are appropriate to the opening of an aseptic cavity, while the same precautions should be observed throughout the operation.

The only instrument needed for the opening of the tympanum through the membrana tympani is a paracentesis needle, but, as the exploratory operation may include mechanical tests for the mobility of the ossicles and may lead to the performance of *plicotomy, synæchtomy, tenotomy of the tensor tympani* or of the *stapedius* muscle, *circumcision of the stapes* in the fenestral niche, or even, in extreme cases, the attempt at the *removal of that bone,* the following instruments should be provided: Two angular knives, one right angle and one at an angle of forty-five degrees for plicotomy, tenotomy, and the division of articulations; two blunt hooks, one large, for testing the mobility of the larger ossicles, and the other for manipulation of the stapes; a small paracentesis needle for tenotomy of the stapedius and for operation in the stapedial niche; two pairs of fine angular forceps, one straight and the other curved upward slightly at the tip.

In addition to these instruments and a number of sterilized cotton-tipped probes, there should be a saturated solution of boracic acid and alcohol and a 1 per cent. sterilized solution of cocaine; the former for dipping the instruments before using, and the latter for the purpose of local anæsthesia and to temporarily check congestion and hemorrhage.

The **details of the operation** are as follows: The patient is seated in a chair, the head being firmly supported by an assistant, who alters its position from time to time according to the directions of the operator.

Under good illumination the first incision is made with the paracentesis knife close to the periphery of the membrana tympani, opposite the round window, and carried upward along the periphery, with or without successive applications of cocaine solution on a cotton-tipped probe to

the cut edges as the sensitiveness of the patient may demand : this first portion of the cut ends at a point close to the short process of the malleus, and is thence carried downward along the posterior border of the long process of the malleus.

The resultant flap usually curves outward and downward, and permits free access to the parts beneath : when this does not occur the flap may be pulled gently outward by means of the blunt hook.

Through the opening thus afforded it is possible to test the mobility of the ossicles, to make tactile examination of the parts beyond sight, and to perform such operations as the tests of hearing and the tactile examinations may indicate, including, for example, divisions of folds and adhesions, mobilization of the ossicles, tenotomy of the stapedius and tensor tympani muscles, circumcision of the stapes, and division of the incudo-stapedial joint, without local anæsthesia, except in so far as the membrana tympani is concerned, the absence of general anæsthesia permitting tests of hearing at progressive stages.

At the conclusion of the examination or operations within the tympanum, as the case may be, the flap in the membrana tympani is replaced by applying to its outer surface a disk of thin glossy writing-paper previously dipped in a weak corrosive solution : this disk is introduced on a moist cotton-tipped probe, kept in contact with the flap for a few seconds until it adheres to it, and then, carrying the flap with it, is pressed upward until the paper also adheres to the drumhead above the cut, thus sealing the wound and keeping its edges in apposition.

If aseptic precautions have been properly taken, the wound in the drumhead closed in this manner usually heals by first intention.

Operation for the removal of the membrana tympani, malleus, and *incus* for the purpose of improving the hearing in cases of non-suppurative diseases of the middle ear, as originally proposed by Kessel, is very similar to the operation for the removal of the malleus and incus in cases of suppurative disease, and should be done with the most careful attention to asepsis.

This operation, undertaken for the improvement of hearing, is of little benefit unless it take into consideration also the release of the stapes and its possible utilization as the point of contact for some form of artificial drumhead.

In acute inflammation of the middle ear incision of the membrana tympani may be required either for purposes of phlebotomy or for the release of secretions retained within the middle ear.

In cases of acute congestion occurring in the upper portion of the tympanum, and characterized subjectively by intense pain and objectively by congestion and swelling of the upper, more vascular portion of the membrana tympani and the upper portion of the inner end of the external auditory canal, prompt action for the relief of the engorged tissues sometimes cuts short what otherwise would be the inception of a serious and prolonged inflammatory process. The purpose of the incision being to divide one of the principal blood-supplies of the membrana tympani, the cut should be made along the posterior superior periphery, from below upward, and ending at the short process of the malleus. After cessation of the temporary hemorrhage the ear should be dressed with dry cotton wicks.

Incision of the membrana tympani for the release of fluid contained within the tympanum should be made by the means of the paracentesis

needle, preferably in the inferior posterior segment, parallel to the periphery of the drumhead, and should be proportionate in size to the density and tenacity of the fluid to be evacuated; while in view of the sometimes considerable swelling of the mucous lining of the tympanic cavity accompanying conditions which render paracentesis necessary, care should be taken that the opening is not only sufficiently large to permit the free flow of fluid, but also deep enough to effectually penetrate the swollen mucous membrane.

Redundant granulation-tissue and polypi are among the common accompaniments of chronic suppurative disease of the middle ear, and may spring either from the mucous membrane of the tympanic cavity, from the edge of a perforation of the membrana tympani, or, from the inner end of the external auditory canal, and vary in structure and size according to their point of origin and the space afforded them for growth. They may be removed either by touching with astringents or caustics, or, operatively, by means of the forceps, the curette, or the wire snare, the latter instrument being especially applicable to the larger and firmer growths. The stump remaining after successful application of the snare should be curetted or treated with caustics until it has entirely disappeared, it being remembered that a too free use either of the curette or escharotics may result in stimulation which will favor redundant tissue-growth and even clinical simulation of a malignant growth, or may cause inflammation of the surrounding tissues.

Granulations springing either from the wall of the canal, from the mucous membrane of the tympanic cavity, or from the ossicles as the result of a circumscribed necrotic process in the bone, may likewise be removed by means of a small tubular snare, curved forceps, or the curette, and their bases subsequently cauterized.

Limited necrosis of the inner end of the canal, of the wall of the tympanic cavity, or of the ossicles is best dealt with by means of small and appropriately shaped curettes, or, in the latter case, if the necrotic process is extensive, complete removal of these bones may be necessary.

By means of a paracentesis needle and an angular knife such portions of the membrana tympani as remain should be excised, the tendon of the tensor tympani muscle and all adhesions between the malleus and inner tympanic wall divided; the anterior and posterior ligaments of the short process of the malleus should next be cut, and a spatula-shaped knife carried along the neck of the malleus between its head and the outer tympanic wall, and moved backward and forward to divide the external ligament of the malleus and any existing adhesions; especial care being taken in effecting this division and in freeing the region of the short process, it having sometimes happened that with the extraction of the malleus the soft tissues have been pulled away from the outer wall of the epitympanic space and the superior wall of the external auditory canal.

When the incus is in place it should be first removed, and if its attachment to the stapes remains, this should be divided by means of an angular or rectangular knife, the cutting motion in dividing the joint being from behind forward, in order to make traction against, rather than with, the pull of the stapedius muscle: the complete division of this joint is usually signalized by the dropping downward and outward of the long process of the incus, the preponderating weight of that bone above its axial line of movement tending to carry the body of the bone inward and its descending process outward. Under these conditions the long process of the incus may be seized by the curved forceps and the bone extracted by a direct pull downward and outward. Where this is not possible, however, and the incus remains above the line of sight, or, separated from its articulation with the malleus, is drawn upward and backward by the pull of its posterior fan-shaped ligament, it

should be carefully searched for with a bent probe and extracted either by means of one of the various incus-hooks or a long curved curette.

The *removal of the malleus*, released from its various attachments, is effected either by means of the forceps already mentioned, or, better still, by encircling the neck of the bone above the short process with a tightly drawn loop of a wire snare, the bone then being drawn downward and outward with a slight rotating motion.

When, as is sometimes the case, the lower part of the malleus has been destroyed by necrosis and only the head or a part of it with the neck remains, the location of this remaining portion should be determined by tactile examination with a bent probe, and its removal effected either by means of a pair of long curved forceps, an incus-hook, or a cup-shaped curette. In the event of caries of the head of the stapes the carious portion may be removed by means of the forceps or curette. After operation the tympanic cavity should be subjected to careful tactile examination to detect any points of necrosed bone, which should in their turn be curetted; redundant granulation-tissue should be removed, the tympanic cavity thoroughly cleansed by syringing with a weak antiseptic solution, and the ear stopped with absorbent cotton.

The subsequent treatment, aside from any further curetting which may be necessary, should consist in syringing with a potassium permanganate or mild astringent solution, touching of granulations, instillation of alcohol, and the insufflation of powdered boracic acid, as the condition of the individual case may demand.

In all cases of limited necrosis of the ossicles or of portions of the tympanic wall, it is possible that the operative procedure above mentioned may be unnecessary, and that the desired improvement may be effected by use of the middle-ear syringe and insufflation of powders. Local treatment of this kind, sufficiently persisted in, has been found efficacious in the majority of cases in which the necrosis has not been extensive.

The Mastoid.

The **mastoid operation** may be properly considered to include not only the opening of the mastoid cells themselves and the establishment of free communication through the mastoid antrum with the middle ear, but also the removal of the bony wall forming the boundary between the mastoid and the external auditory canal, and of the superior posterior bony lamina which forms the outer and lower limit of the epitympanic space, with also such diseased portions of the mastoid walls elsewhere as may be necessary.

The *initial lesion*, of which the establishment of an acute infectious process in the cellular structure of the mastoid portion of the temporal bone is a complication, may occur as the result of an *inflammatory process in the soft parts of the external auditory canal*, a circumscribed periostitis being followed by denudation and death of bone, or, more frequently, may be the sequence of an acute congestion or of an *acute infectious process in the middle ear*. In acute congestion of the middle ear with an accompanying congestion of the lining membrane of the mastoid cells, where the pain, the temperature, and the pulse, the tenderness to pressure in the mastoid region, especially over the mastoid antrum, the digastric fossa, and at the mastoid tip, as well as the objec-

tive symptoms in the middle ear, indicate the necessity for an opening into the mastoid for purposes of local phlebotomy or with a view to further interference, the operation should be done only under the most

FIG. 444.

FIG. 445.

Outer surface of mastoid and membrana tympani.
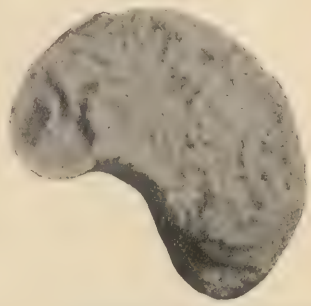
Interior of mastoid and inner surface of membrana tympani.

rigid asepsis, and should be preceded by a free crescentic incision along the superior posterior periphery of the drumhead, in case that structure is intact. An incision in this location affords not only the freest oppor-

FIG. 446.
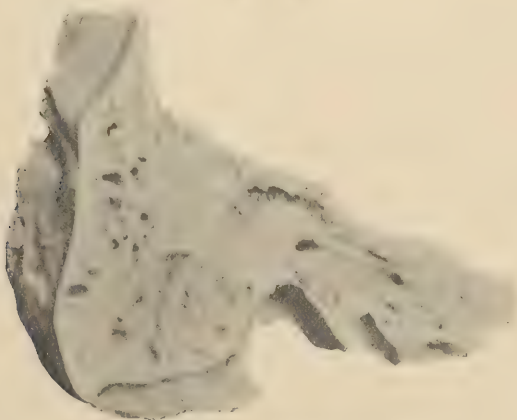
Vertical section of mastoid process.

tunity for drainage from the mastoid antrum, but also, as in the operation of exploratory tympanotomy, provides a flap which can easily be replaced with the least possible interference with the integrity of the drumhead and its subsequent value as a vibrating membrane.

The extent of the *operative invasion of the mastoid cavity in the acute congestive cases* must depend upon the degree to which the bone of the mastoid cortex, and the more delicate walls of the mastoid cells, have become affected, and may vary from a simple opening of the outer mastoid wall to the establishment of a free communication with the mastoid antrum and the middle ear.

The actual value of a simple incision through the soft tissue over the mastoid down to the bone only is that of an extensive superficial mastoid

phlebotomy, except in those cases of neglected suppurative middle-ear disease with mastoid complications, where the pathological process has sought its own relief by perforation of the cortex, and the incision which gives vent to the contained pus is but the preliminary to a thorough opening and evacuation of the mastoid itself.

In an uncomplicated case of mastoid operation the preliminary incision should be made from above downward, at a distance of about a half inch backward from the insertion of the auricle and following its curve : the upper portion of the cut should be vertical, and the lower portion inclined outward through the soft tissues ; small vessels should be seized and twisted, and larger vessels ligatured, though this is rarely necessary, the use of hot water and the pressure of the retractors being usually sufficient to stop hemorrhage from the flaps : this having been effected and the bone bared of periosteum, its surface, unless there has been spontaneous perforation of the cortex, should be carefully searched for evidence of congested or softened bone, such point being chosen for the preliminary opening. This, together with the subsequent operation within the mastoid, except as regards curetting, may be effectually accomplished by means of the chisel or gouge and mallet, though in many cases the broad-bladed and long-handled drill worked by hand and guided by an educated tactile sense is a convenient and valuable substitute.

The opening in the cortex should be sufficiently large to permit free access to the mastoid cavity, and the process of removal of the diseased

Fig. 447.
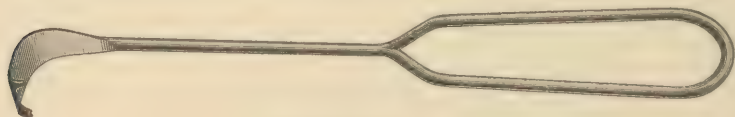
Hammond's retractor.

tissue may, in the majority of cases of mastoid disease, be sufficiently and effectively accomplished by means of sharp spoons, the process of

Fig. 448.

Mastoid curette.

curetting being accompanied from time to time by careful probing and by ocular inspection when possible, the greater part of the operation,

Fig. 449.

Mastoid drill.

however, as a rule, being done by the sense of touch, and requiring therefore for its complete performance a tactile knowledge of distances and of location of important parts.

In both the earlier stages of mastoid disease and in those cases in which the cavity is found to be filled with broken-down cell-walls, granulomata and pus, but without caries of the antrum or epitympanic space, after thorough evacuation the mastoid may be allowed to fill with blood-clot, the surface of the wound being flushed with hot water and a simple baked dressing applied.

In cases of long-continued or neglected mastoid disease with spontaneous perforation of the cortex in the digastric fossa or at the tip, the pus making its way downward by gravity into the tissues of the neck, the preliminary incision should be carried backward over the digastric region and continued downward sufficiently to permit free access both to the mastoid tip—which wherever carious should be removed—and to the upper portion of the course followed by the pus downward, counter-incisions in the neck below being made to afford drainage.

In cases of prolonged chronic mastoiditis the resultant thickening of the cancellated structure furnishes a hard bone, often of considerable thickness, through which it is necessary to chisel or drill before reaching the objective point in the pneumatic cells of the mastoid or of the mastoid antrum, while in cases of prolonged suppuration with necrosis of the antrum or the accumulation of cholesteatomatous masses the simple mastoid operation above mentioned may need to be extended to removal of the anterior mastoid wall and the outer boundary of the upper tympanic space, and the creation of one large permanent opening with inverted skin-flaps, or it may be but the preliminary to an opening of the cranial cavity in cases of sinus thrombosis or otitic brain-abscess.

CHAPTER XX.

ON SKIAGRAPHY, OR THE APPLICATION OF THE RÖNTGEN RAYS TO SURGERY.

By Roswell Park, M. D.

ENOUGH time has elapsed since the announcement by Professor Röntgen, of Würzburg, of a new manifestation of energy, which he called the "*x* rays," and which others have generally consented to name the "Röntgen rays," to demonstrate their value and their applicability for limited but important purposes in surgery. To the method in general the name *skiagraphy* is now generally applied, while the pictures taken by the new process are sometimes termed *skiagraphs* or *radiographs*.

While Röntgen is undoubtedly to be credited with the first application of what is now known and with the introduction of a suitable method, he, nevertheless, is not the first man to recognize that energy proceeds from the cathode in high vacuums. Hertz, a brilliant German physicist, endeavored to demonstrate Maxwell's theory that light-waves are identical with electro-magnetic disturbances in ether, which ether is the all-pervading elastic medium everywhere regarded as pervading space and penetrating all bodies, no matter how solid. Hertz showed that electro-magnetic disturbances in ether were capable, like light, of refraction, reflection, polarization, dispersion, etc. In 1891 he stated that the cathode rays of a Crookes tube were capable of passing through opaque substances in their path inside of the tube. Hertz died an untimely death, and his investigations were continued by Lenard, who in 1893 announced that these same cathode rays escaped from the tube to a certain extent, and that he had obtained photographs through opaque substances by their agency. His simple statement, however, attracted no attention.

Röntgen was following along the lines of Hertz's and Lenard's investigations when, upon the 8th of November, 1895, while working with a Crookes tube covered with a shield of black cardboard, he noticed that a piece of barium platino-cyanide paper became phosphorescent. It was this which led him to further investigation and the announcement of his "*x* rays." Further tests within the ensuing few days showed the penetrative power which they possessed, as well as their property of affecting photographic plates as does light; furthermore, that they could not, like light-rays, be reflected, concentrated, or diffracted outside the tube in which they originate.

The possibility of provoking the phenomenon of the Röntgen rays appears to be inseparably connected with the *ultra-gaseous state of matter*, which Crookes called the *radiant* or *fourth state*. All gases are now regarded as composed of countless molecules continually moving and jostling each other with incredible velocity. When a glass tube containing air is exhausted, the number of these molecules is diminished, and each molecule is given a longer free path. If exhaustion be carried to, say, one-millionth of an atmosphere, the minute portion of air remaining is exalted to what we may call the radiant state, and here new and strange phenomena may be evoked. A tube thus exhausted, no matter what its shape, is known as a Crookes tube, and, as ordinarily constructed, is more or less cylindrical or pear-shaped, with a platinum electrode at either extremity. It is from the cathode that the *x* rays proceed, and it appears that from the impact of either the ether waves proceeding in a longitudinal direction or of solid particles projected from the cathode upon the glass the peculiar energy proceeds. The glass becomes *fluorescent*, and the "rays" escaping from the tube have the power of provoking fluorescence in certain other materials—the diamond, for instance, in feeble degree—while potassium platino-cyanide or barium platino-cyanide and calcium tungstate in particular can be thrown into a high degree of fluorescence.

Advantage has been taken of this fact by Edison and others in the construction of the so-called *fluoroscope*, which is nothing but a conveniently shaped box with a shield adapted about the eyes, so that no light may enter, while at one end is a cardboard which has been spread with mucilage, upon which, before drying, *crystals* of one of the above-mentioned fluorescent salts have been sprinkled. In the presence of a Crookes tube, suitably energized, objects which are more or less opaque to the Röntgen rays will cast a shadow upon this fluorescent screen, while the soft tissues of the body and many non-metallic objects permit their freer passage. Thus a hand held between the screen and the tube will cast a perfect *silhouette* or shadow, while solid particles, needles, buckshot, pieces of glass, etc., will be made conspicuous as upon a photographic plate.

Several theories have been advanced to account for these phenomena. One theory supposes them to be ultra-violet waves of light. According to another, they are purely longitudinal ether waves, having no lateral propagations as have ordinary light or other waves. A third theory would account for them as the result of electrification—*i. e.* by an electro-static effect between the object and the plate, due to the energy produced by the excited Crookes tube. A fourth hypothesis is that they consist of material particles directly projected from the cathode. Tesla, in the *Electrical Review* of July 8, 1896, has announced his view, in accordance with the last suggestion, that these rays are not vibrations, but actual streams of fine particles passing directly through the pores of material bodies ; and he has brought forward a special experiment that seems to materially strengthen his hypothesis. Certain it is that by continued use the electrodes are disintegrated to a marked degree, and that discoloration and disorganization of the part of the tube bombarded by these particles do take place. These particles are so minute as to be able to pass through the walls of the bulb, according to Tesla's view, or else tear off particles from the glass which are themselves projected. At all events, impact and consequent injury or shattering seem absolutely necessary for their projection. The principal source of the rays is certainly the place of first impact.

FIG. 450.

Diagram illustrating Tesla's experiments.

Tesla has suggested the following experiment as a corroboration of his view : "A single electrode, *E*, consisting of a massive aluminum plate, is mounted on a conductor, *C*, provided with a glass wrapping, *W*, as usual, and sealed in one of the ends of a straight tube, *B*, about 5 cm. in diameter by 30 cm. long. The other end of the tube is blown out into a thin bulb of a slightly larger diameter, and near this end is supported on a glass stem, *S*, a funnel, *F*, of thin sheet platinum. The particular object of the presently described construction was to ascertain whether the rays generated at the inner surface of the platinum funnel, *F*, would be brought to a focus outside of the bulb, and, further, whether they would proceed in straight lines from that point. For this purpose the apex of the platinum cone was arranged to be about 2 cm. outside of the bulb. When the bulb was properly exhausted and set in action, the glass wall below the funnel, *F*, became strongly phosphorescent, but not uniformly, as there was a narrow ring, *RR*, on the periphery brighter than the rest, this ring evidently due to the rays reflected from the platinum sheet."

When a phosphorescent screen was held outside the bulb and shifted to and fro, it was found that the rays did focus. This experiment illustrates something more than the mere propagation of these rays in straight lines—namely, that the fluorescent glass wall, when the platinum was present, emitted practically no rays, whereas had the platinum not been present it would have been, under similar conditions, an efficient source. Tesla explains the absence of radiation from the glass in this tube by assuming that the matter proceeding and reflected from the platinum surface was already in a finely divided state before it reached the glass wall.
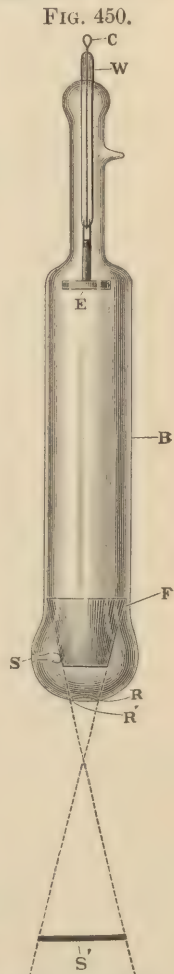
In utilizing the cathodal rays for surgical purposes either the *fluoro-scope* or the *photographic plate* may be employed. With the former a momentary shadow can be obtained without being recorded, by which information of much value may often be gained within a few seconds; but for permanent record or for purposes of more accurate study photographs (*i. e.* skiagraphs) must be made. For this purpose the ordinary dry plate may be employed, certain manufacturers now making plates for this special purpose which are considered more sensitive. One of these plates in any ordinary plate-holder, of size large enough to accommodate the desired picture, is used according to the necessities of the case.

It will be sufficient for a hand or arm to simply lay it over the plate-holder and rest both upon a table, the Crookes tube being fastened above the part to be photographed. In the case of a foot the plate may be placed upon the floor, the foot rested upon it, and the tube be suitably placed. In any event, no metal, such as rings, etc., should be allowed to disfigure or render uncertain the picture to be taken. Thus, while it is not necessary to take off the stocking, it will be necessary to take off a shoe which contains iron nails, a glove with metal buttons, etc. In order to avoid lack of definition, it will be well to bandage the limb to the plate-holder or to fasten it thereto with strips of adhesive plaster. It is not necessary to take off wooden or plaster splints. In the case of the trunk the patient may lie upon the plate-holder or a flat table. In the case of the skull the plate-holder should be strapped or bound to the head, and the whole held in some suitable head-rest because of the long exposure required. The time required for exposure can never be determined without some experimentation, for it will vary with the size of the coil, the voltage of the primary current, the size of the lamp, and the degree of vacuum within it. With perfect apparatus good photographs of the hand, foot, etc. can be taken in from two to five minutes, while with defective apparatus this time may be lengthened to half an hour or even an hour. For the body and the skull longer time is required—at least with most of the apparatus on the market at the date of this writing.

The Crookes tubes become intensely heated at the point of impact of the cathode rays, and it is possible to soften the glass to a degree permitting change of its shape, or to so heat the tube when placed close to the patient as to make it uncomfortable or unendurable. For most purposes a distance of from ten to fifteen inches from the surface is about the best. When it is remembered that these rays proceed in straight lines, it will be easily seen how much distortion of image may occur when the endeavor is made to skiagraph too extensive an area with one tube. On the other hand, with two or more there may be some confusion of images. The method in general use for skiagraphing a hand can be seen from the accompanying illustration (Fig. 451).

Dr. W. J. Morton of New York made the discovery that the disruptive discharges of *static electricity* could be taken advantage of in skiagraphy, and that shadow pictures could be taken without the use of the Crookes tubes. He also found that better results could be secured by the use of Leyden jars, charged by Holtz's machine and discharged into the vacuum bulb. In this way he has been able to use tubes of

twenty inches in diameter without danger of breaking their walls. By their use he seems to get more rapid oscillations, computed at fifteen millions to the second. While Morton thinks that the best promise for

Fig. 451.
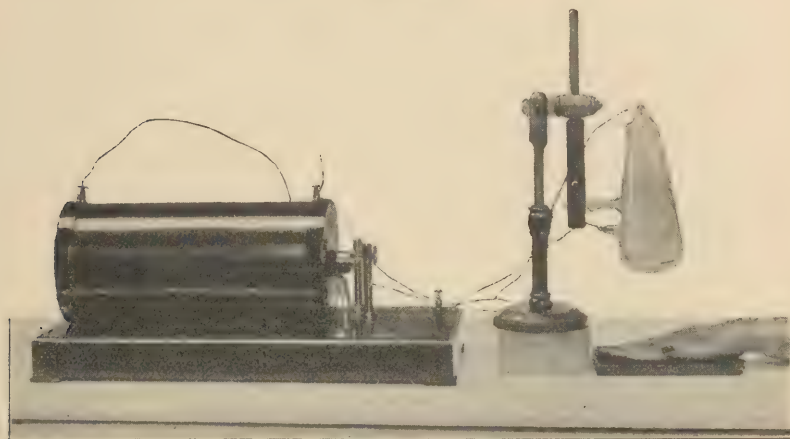
Illustrating method of skiagraphy by use of large induction coil.

the future lies in the use of large Holtz machines, he at present uses no Leyden jars, but does use a vacuum tube. He has succeeded in getting good pictures with the ordinary radiometer of large size fitted with tin-foil electrodes. Most operators use large induction coils capable of throwing a spark at least eight inches. The efficiency (*i. e.* insulation) of the coil is greatly enhanced by *immersing it in oil.*

Quite recently, at the date of present writing, Le Bon has discovered another manifestation of energy, which he calls "la lumière noire." It is quite certain that the retinæ of different animal forms are sensitive to light in different ways and to different degrees. There is every reason to think that certain rays of the spectrum which do not affect the human retina do nevertheless affect the retinæ of many of the lower forms of animal life, just as it is known that the ultra-violet rays, invisible to the eye, will yet affect the sensitive plate. The terms "visible" and "invisible" are therefore purely relative. Invisible light—if one may use the expression—may, then, come through the cathode of a Crookes tube as well as the Röntgen rays, or may be produced from other sources.

Le Bon has recently presented to the Academy of Sciences in Paris the following experiment: An ordinary photographic negative with a developed image is placed over a sensitive plate inside of a light-proof wrapping. The whole apparatus is then covered by a metallic sheet and exposed to the light of a petroleum lamp for about three hours; after which energetic development of the sensitive plate will give a faint image of the negative. If behind the sensitive plate he placed a thin sheet of lead and in front of it a sheet of iron, the same exposure to the same light would give an excellent image instead of a faint one, providing that the two metal coverings were brought in contact. Le Bon thinks that the contact of two different metals gives rise to a slight electric current, whose action, combined with that of the petroleum lamp, makes the plate more pervious to the light. Solar light is said to give the same results, while zinc, silver, and tin, and particularly black paper, are more resistant. While cathodic rays pass easily through the latter, the invisible rays cannot.

Of the practical applications of Röntgen's discovery the profession have been made pretty generally aware through numerous publications in current medical literature. Up to the present their most common

application has been for the purpose of skiagraphing the bones or of detection of foreign bodies—needles, etc.—in the soft parts. By means of Röntgen's discovery it will be hereafter possible to recognize irregularities, deformities, new growths, malformations, the existence of fractures or dislocations, the character of pseudarthroses, variations in density of bone, size and location of sequestra, etc., in at least the bones of the limbs. Much may be told also regarding the perfection of union and solidity of callus after fracture, and even changes which have taken place in the dimensions of the marrow-cavity. By mere study of the osseous skeleton, alone, of mother and fœtus the obstetrician may accurately depict the position of the fœtus shortly before birth. Probably the fluoroscope will suffice for this purpose, it not being often necessary to take a skiagraph.

Inasmuch as mineral matter is the more impervious to these rays, calcareous infiltration of various organs or tissues causes marked relative differences which the expert will in time learn to recognize. Thus, calcareous infiltration of arteries and atheromatous disease may be made actually visible. The exact progress of ossification and of epiphyseal union in the bones of children may also be depicted quite accurately, as well as pathological changes in bone tissue, callus, etc.

For the same reason mineral calculi can be made visible, particularly in the bladder and kidneys; probably also in the ureters, the salivary ducts, etc. On the other hand, calculi composed of organic material, like cystin, and biliary calculi seem strangely pervious to these rays, and are as yet not easily capable of detection by their means. For the dentist fangs of teeth and foreign bodies, as well as the presence of unsuspected fillings, may be clearly indicated, and the presence of supernumerary or non-erupted teeth.

It is in the detection of foreign bodies, especially metallic, that the skiagraph and fluoroscope are often of greatest value. Gunshot missiles of all sizes, from buckshot up to bullets, needles and particles of metal, glass, etc., are capable of easy detection by this means. During the present year a jack-stone, which had become impacted in the œsophagus of a little child, was exactly located and its removal very much facilitated by a skiagraph taken by Dr. White of Philadelphia.

With improvement in technique differences may be quickly made out in the soft parts which we are as yet rarely able to accurately recognize—for instance, the location of the heart, the liver, etc.—while with the fluoroscope and the energetic tube the movements of the viscera may be seen within the cavities of the body during life.

It does not seem necessary to go into further details, but the reader is referred to the plates herewith subjoined for information which may illustrate some of the uses of Röntgen's ray in surgery.

Just at the date of penning this chapter Levy of Berlin has announced the construction of a new Crookes tube, with which he claims to be able to inspect the interior of the antrum, the frontal sinuses, the larynx, and the viscera by using the fluorescent screen. It consists of a vacuum tube with concave electrodes, with a disk of platinum, tilted at 45°, midway between them; this is made the cathode, while the anode is a double one. With this instrument arterio-sclerosis of the large vessels, both in the trunk and the limbs, could be recognized, while shadows were made by calcareous degeneration of old lesions in the lungs and pleuræ. Enlargement of the heart was also made visible.

PLATE XIV.

Clubfoot, Child aged Six Years, showing Overlapping of the Metatarsals ; patient of
Dr. De Forest Willard, by whose permission the illustration is used.

[Skiagraphed by PROF. ARTHUR W. GOODSPEED. Copyright 1896, by WILLIAM BEVERLEY HARISON.]

PLATE XV.

Skiagraph of the Hand of a Young Lady, aged Twenty-six Years, showing a Needle Imbedded in the Muscles for Twenty Years.

[Skiagraphed and loaned by Mr. Herbert B. Shallenberger, Rochester, Pa.   Exposure, 5 minutes.]

PLATE XVI.

An Old Dislocation of the Wrist, with Fracture and Disappearance
of the Styloid Process of the Ulna.
Note the darker shadows of the pisiform bone and the unciform process.

[Skiagraphed and loaned by Mr. HERBERT B. SHALLENBERGER, Rochester, Pa.   Exposure, 10 minutes.]

PLATE XVII.

Skiagraph of Thorax and Arms.

Observe especially the Cervical Intervertebral Substances, Ribs, Clavicles, and Shoulder-joints.

[Skiagraphed by PROF. A. W. GOODSPEED, and kindly loaned by DR. H. W. CATTELL.
From the *International Medical Journal.* Equal definition in one minute.]

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GENERAL INDEX.